US009403100B2

(12) **United States Patent**
Karunaratne

(10) **Patent No.: US 9,403,100 B2**
(45) **Date of Patent: Aug. 2, 2016**

(54) **BASEPLATE ASSEMBLY FOR USE WITH TOY PIECES**

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(73) Assignee: **TechnologyOne, Inc.**, Fremont, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 251 days.

(21) Appl. No.: **13/760,880**

(22) Filed: **Feb. 6, 2013**

(65) **Prior Publication Data**

US 2013/0217295 A1 Aug. 22, 2013

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/681,143, filed on Nov. 19, 2012, now abandoned.

(60) Provisional application No. 61/633,824, filed on Feb. 17, 2012.

(51) **Int. Cl.**

A63H 33/42	(2006.01)
A63H 33/04	(2006.01)
A63H 33/08	(2006.01)

(52) **U.S. Cl.**

CPC ***A63H 33/042*** (2013.01); ***A63H 33/086*** (2013.01)

(58) **Field of Classification Search**

USPC 446/90

See application file for complete search history.

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Primary Examiner — Tramar Harper

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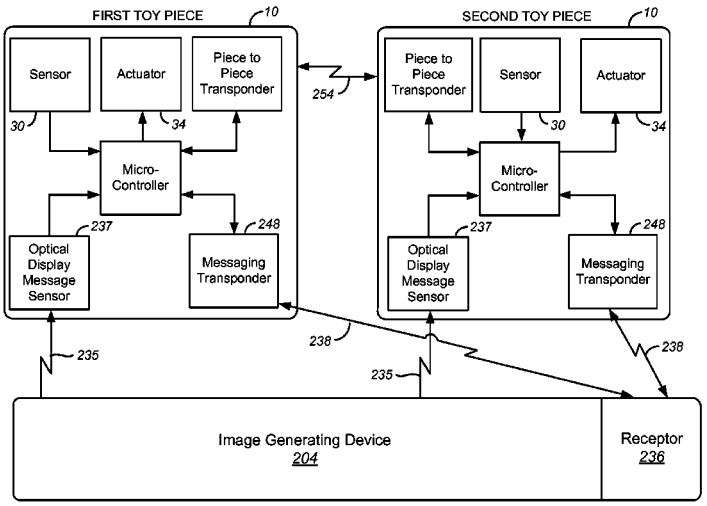
(57) **ABSTRACT**

A baseplate assembly, used with releasably coupleable playing pieces, includes a baseplate operably coupled to an image generating device. The baseplate includes a display region, having playing pieces coupling elements, and means for transmitting images generated by the image generating device to the display region. An image generating and playing-piece-interacting assembly includes a receptor operably coupled to an image generating device, having a display screen for generated images, including integrated visual and optically encoded message images, a playing piece at a location relative to the display screen having an optical display message sensor, and a messaging transponder. The optical display message sensor receives the generated images and generates a first signal at least partially based upon the optically encoded message image. The messaging transponder receives the first signal and generates and sends the receptor a second signal at least partially based thereon.

22 Claims, 36 Drawing Sheets



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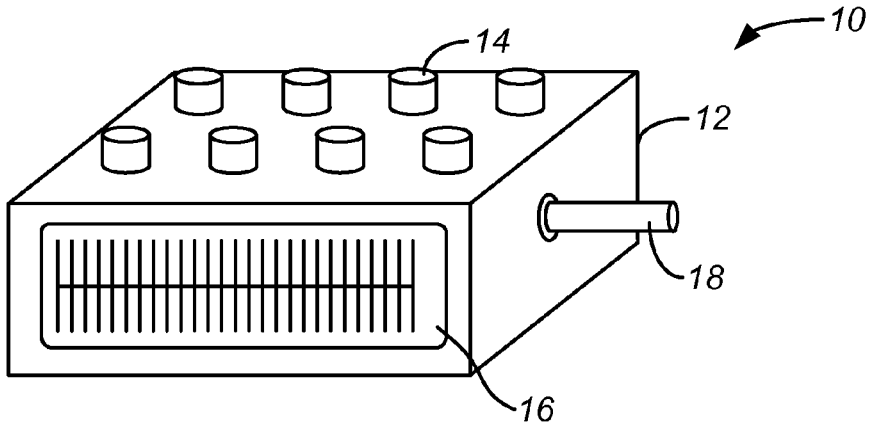
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FIG. 1

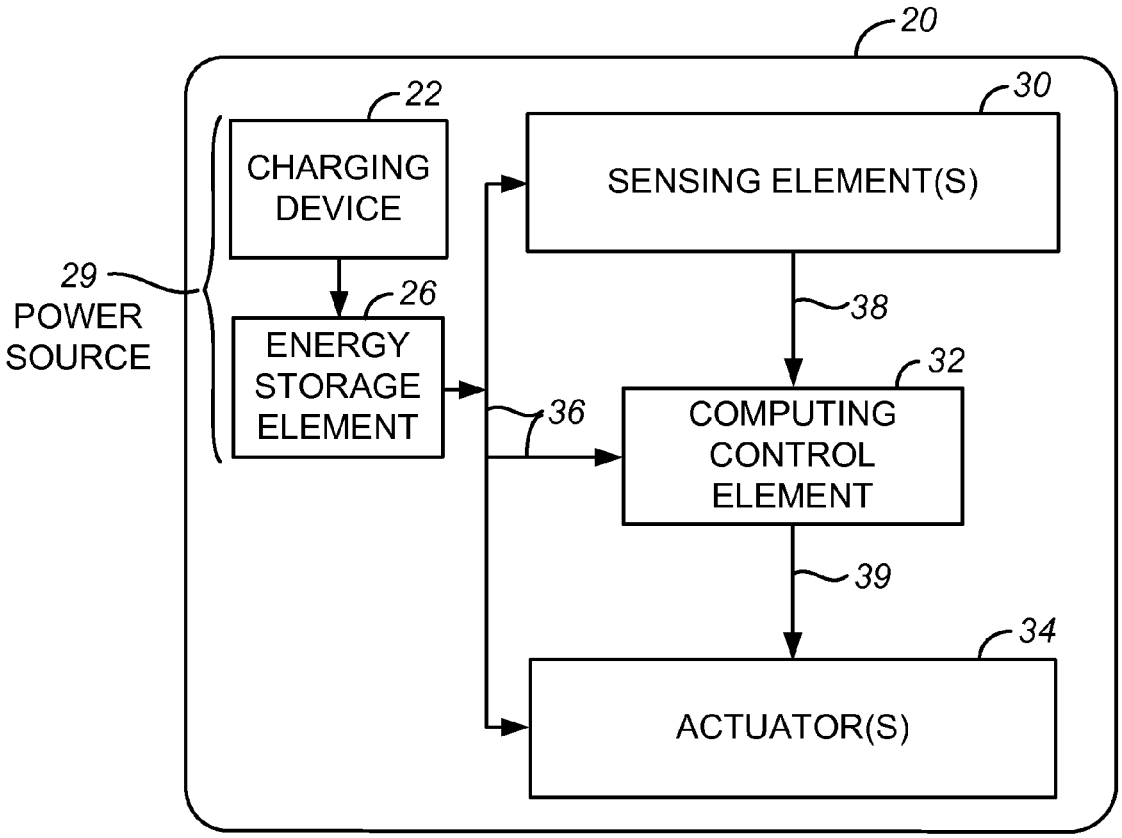

20
22
CHARGING DEVICE
30
SENSING ELEMENT(S)
29
POWER SOURCE
26
ENERGY STORAGE ELEMENT
38
32
36
COMPUTING CONTROL ELEMENT
39
34
ACTUATOR(S)

FIG. 2

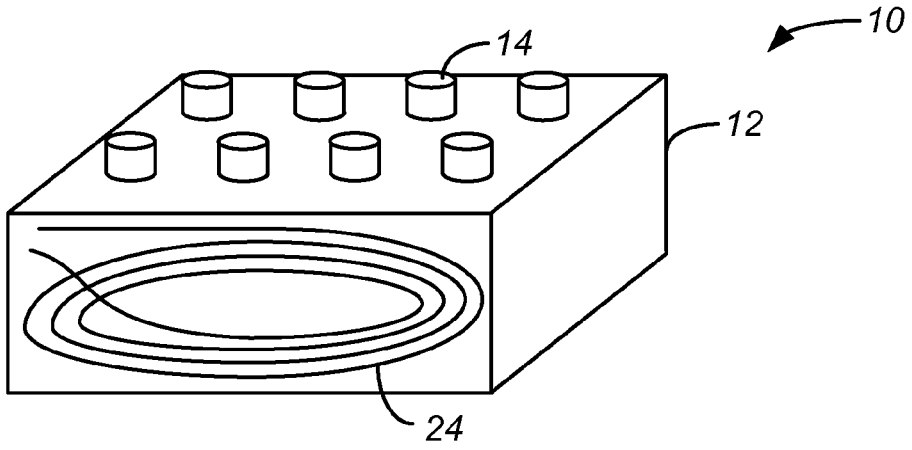
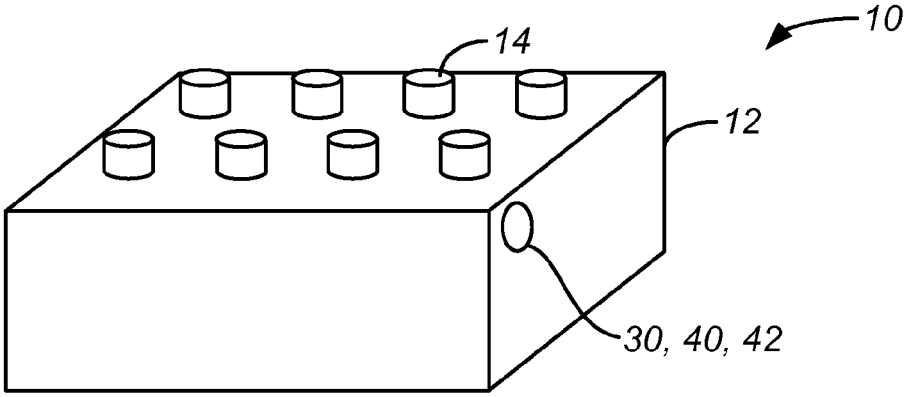


FIG. 3



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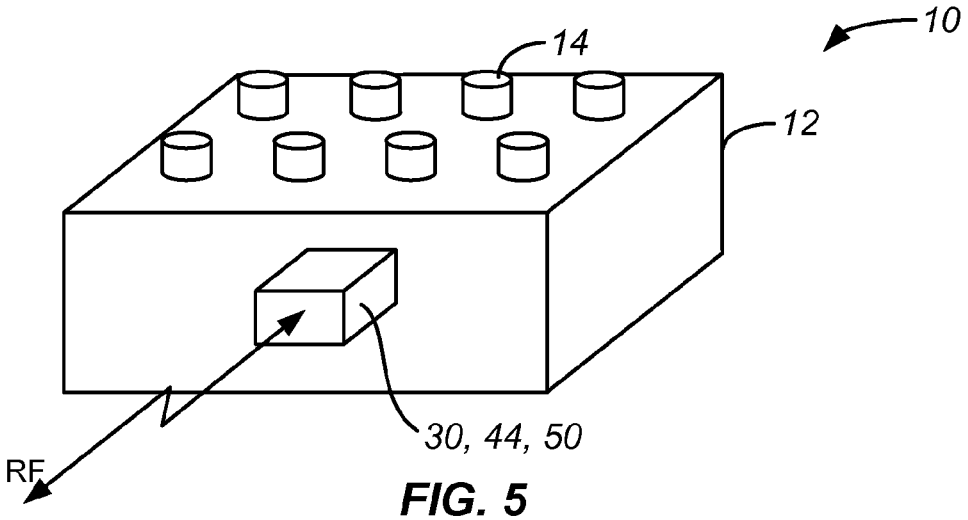

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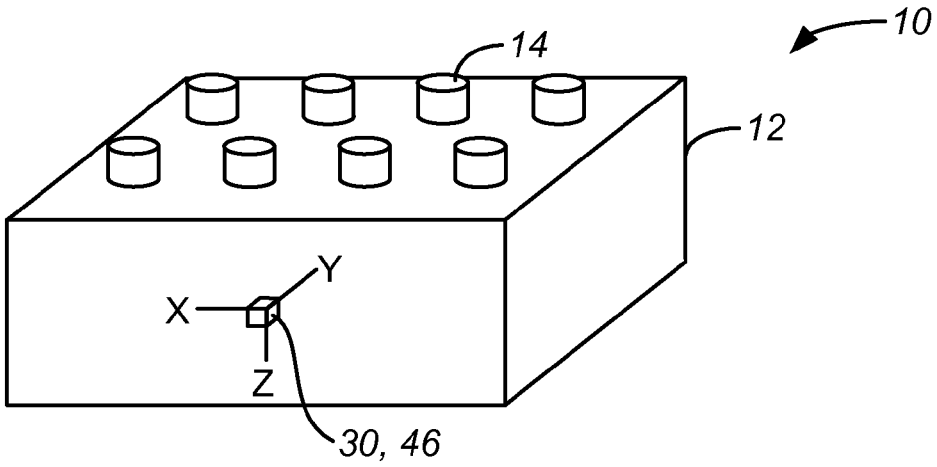

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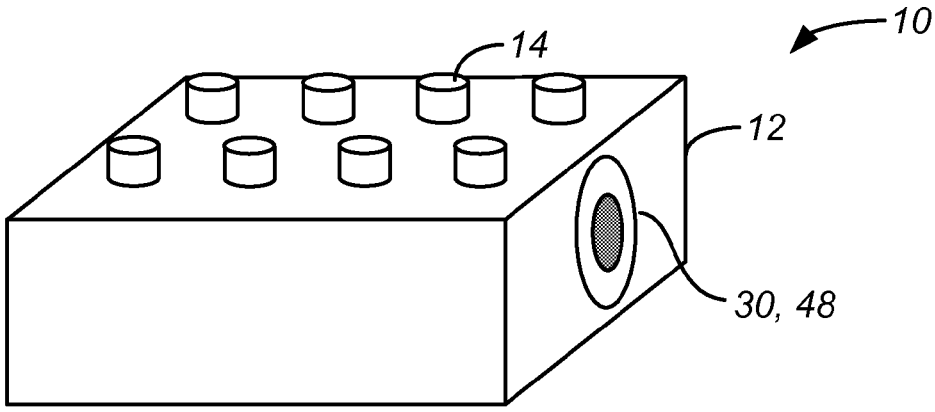

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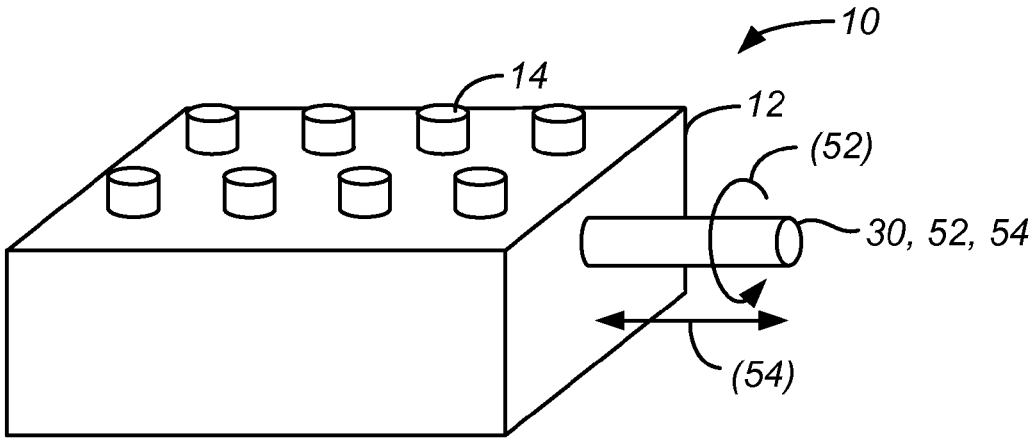


FIG. 8

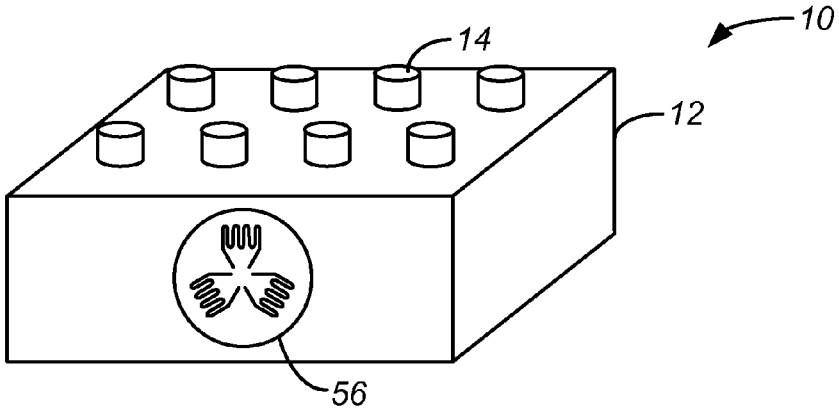


FIG. 9

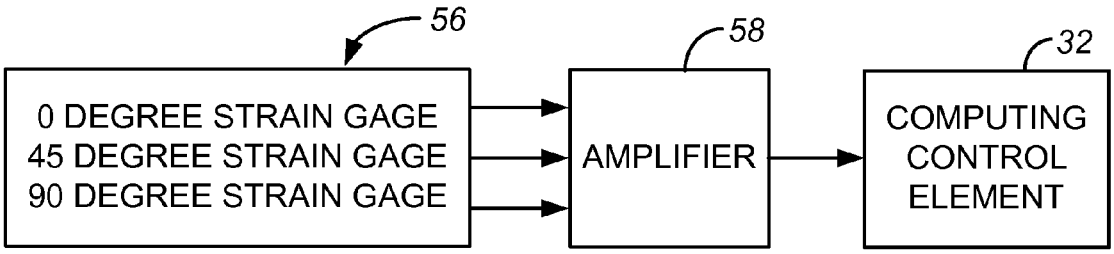


FIG. 10

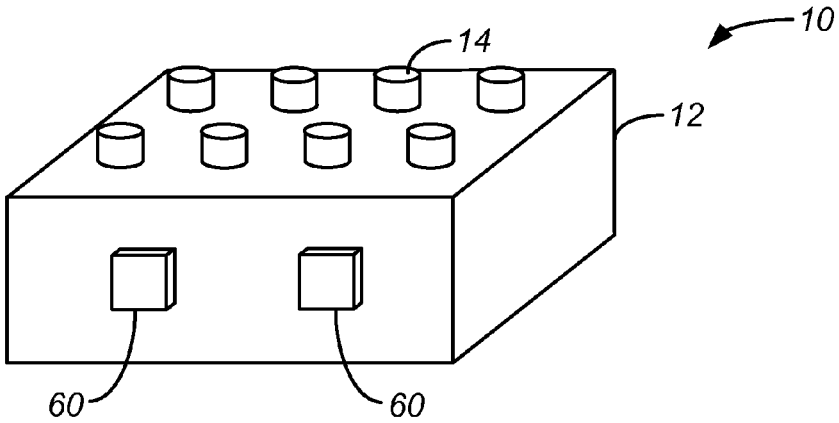


FIG. 11

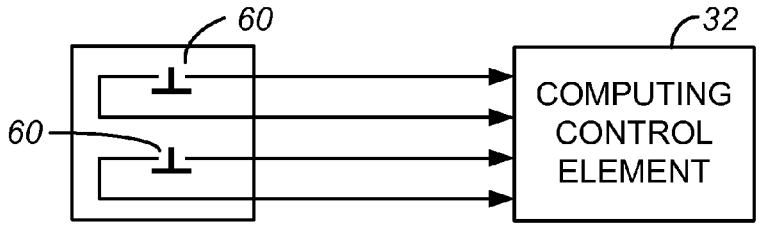


FIG. 12

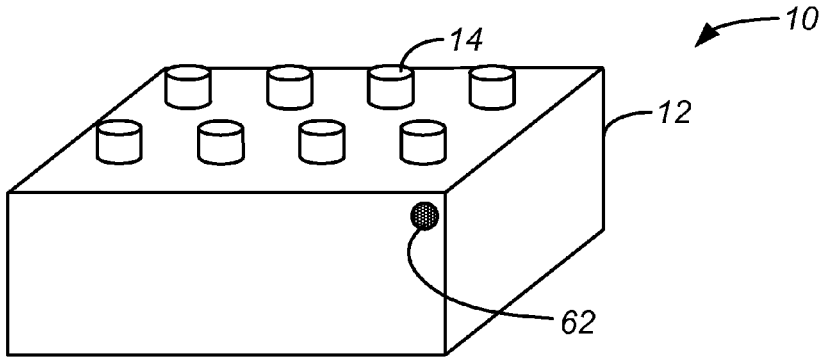
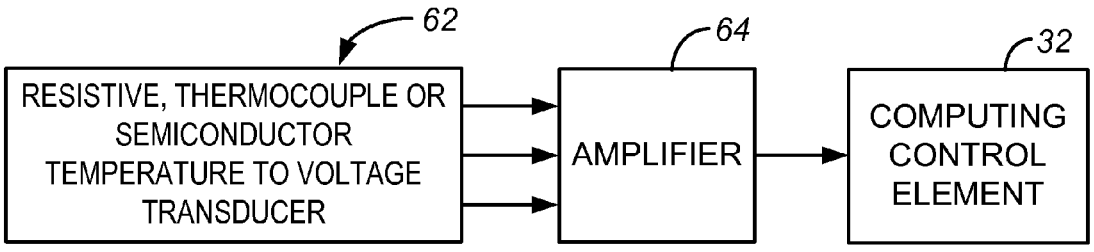


FIG. 13



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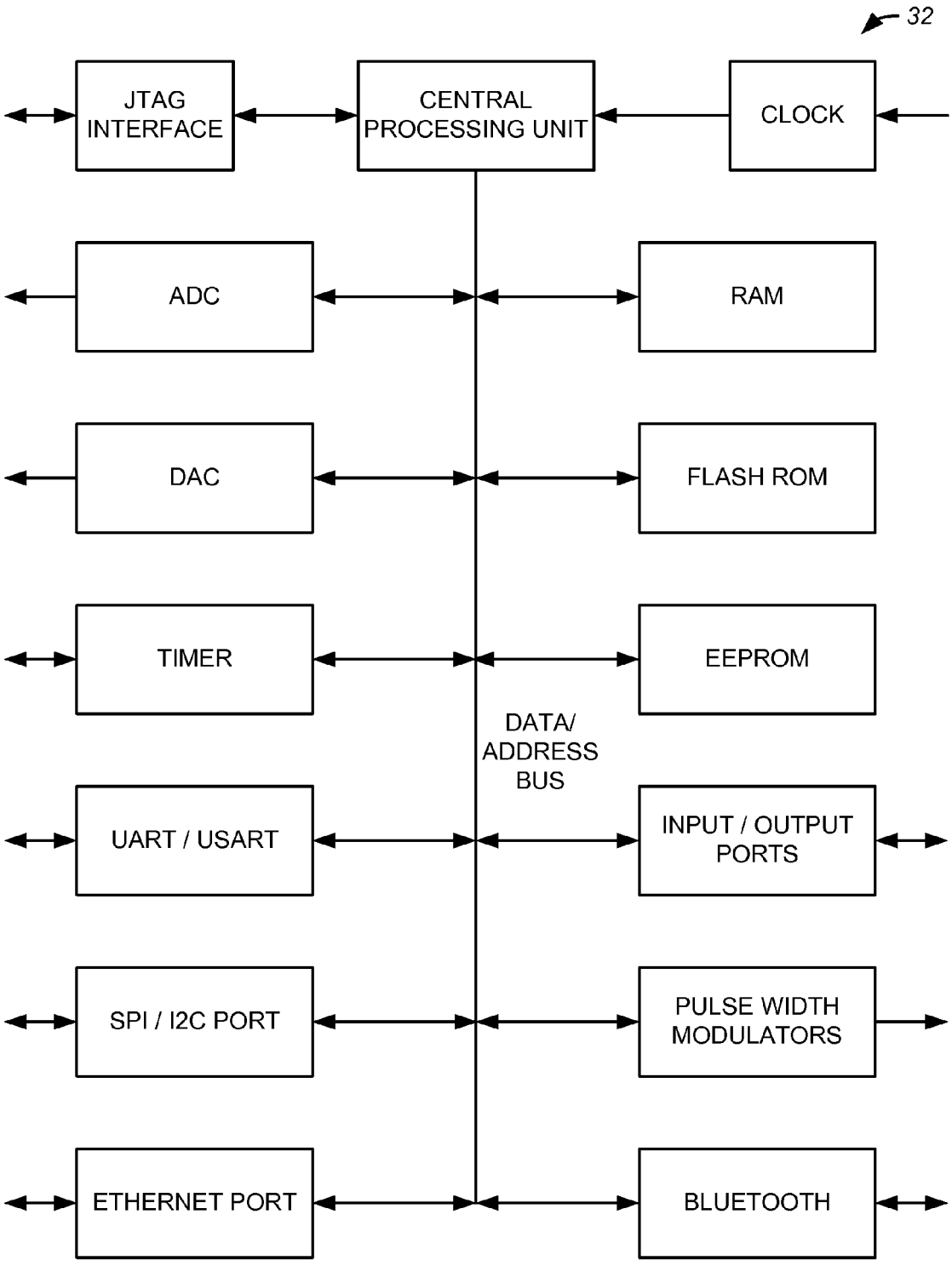

32
JTAG INTERFACE
CENTRAL PROCESSING UNIT
CLOCK
ADC
RAM
DAC
FLASH ROM
TIMER
EEPROM
DATA/ ADDRESS BUS
UART / USART
INPUT / OUTPUT PORTS
SPI / I2C PORT
PULSE WIDTH MODULATORS
ETHERNET PORT
BLUETOOTH

FIG. 15

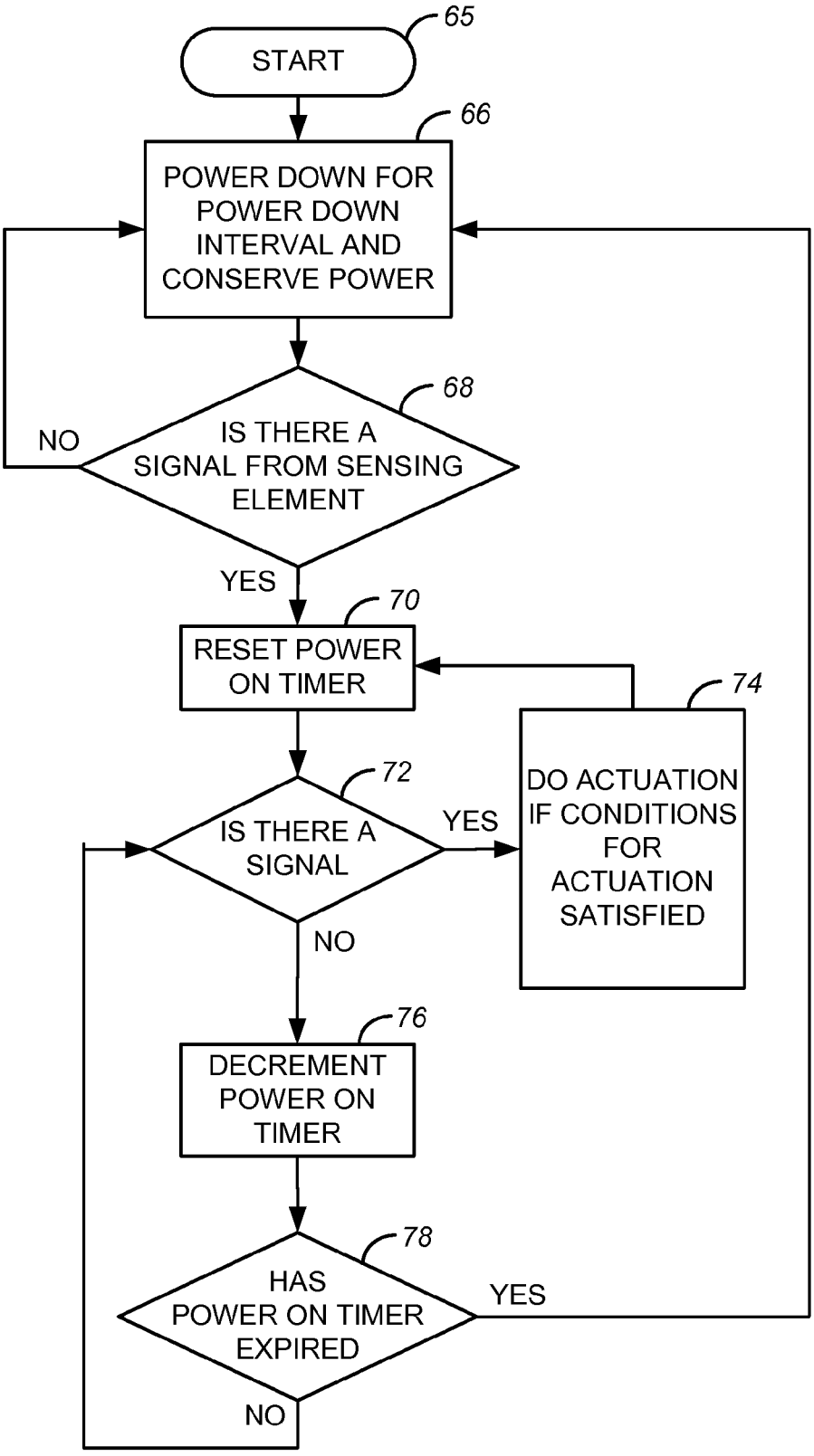

65
START
66
POWER DOWN FOR POWER DOWN INTERVAL AND CONSERVE POWER
68
IS THERE A SIGNAL FROM SENSING ELEMENT
NO
YES
70
RESET POWER ON TIMER
74
DO ACTUATION IF CONDITIONS FOR ACTUATION SATISFIED
72
IS THERE A SIGNAL
YES
NO
76
DECREMENT POWER ON TIMER
78
HAS POWER ON TIMER EXPIRED
YES
NO

FIG. 16

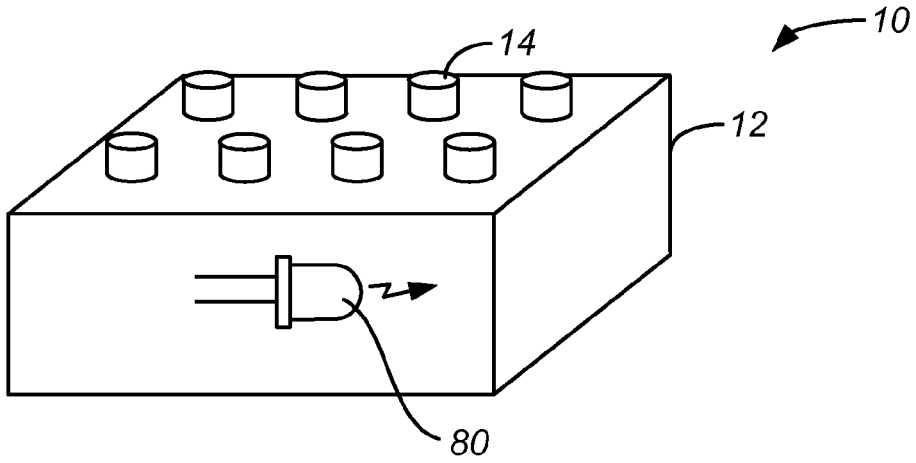
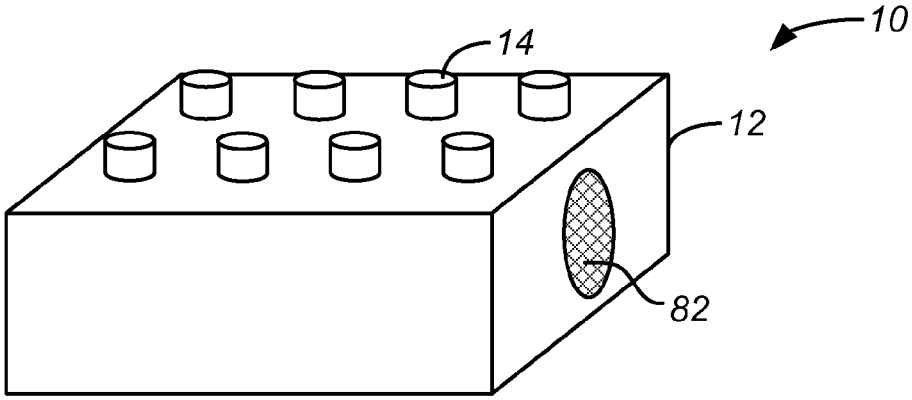


FIG. 17



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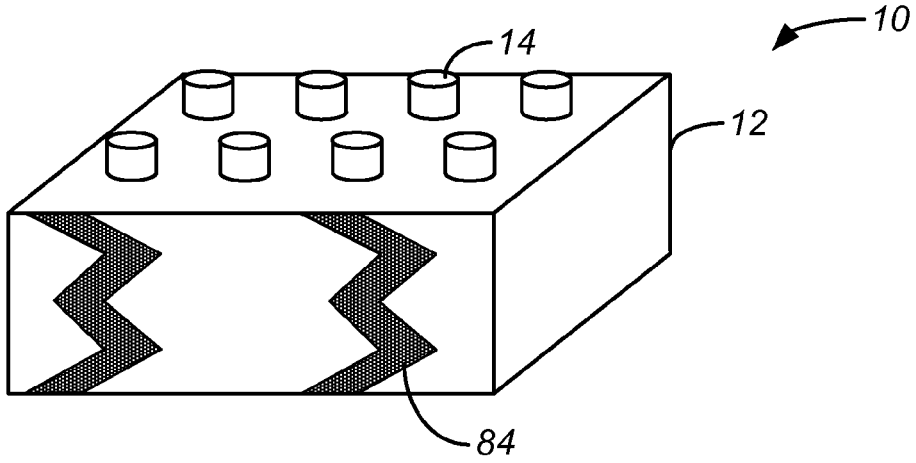

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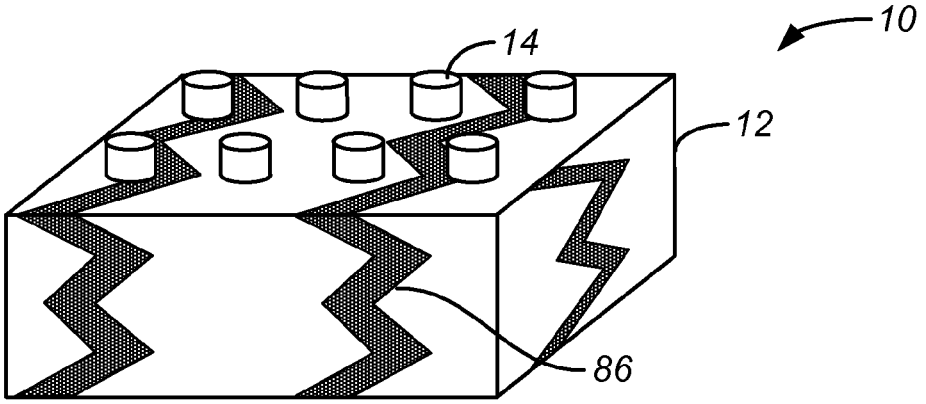


FIG. 20

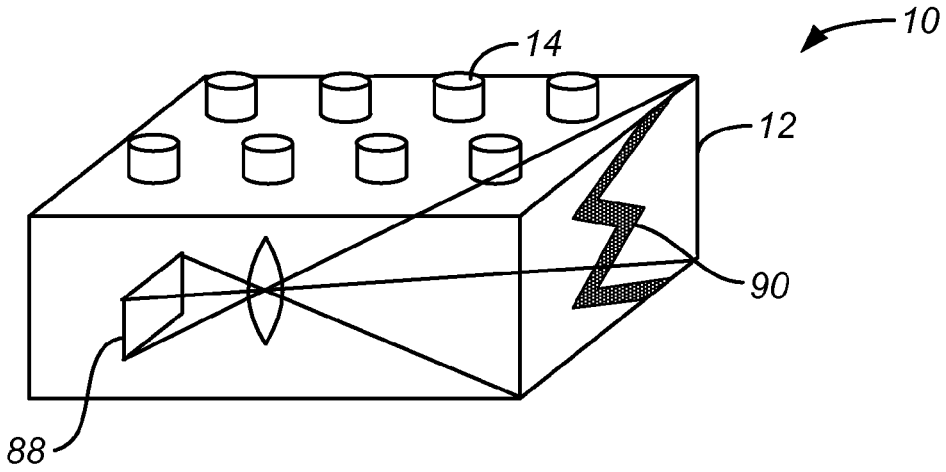


FIG. 21

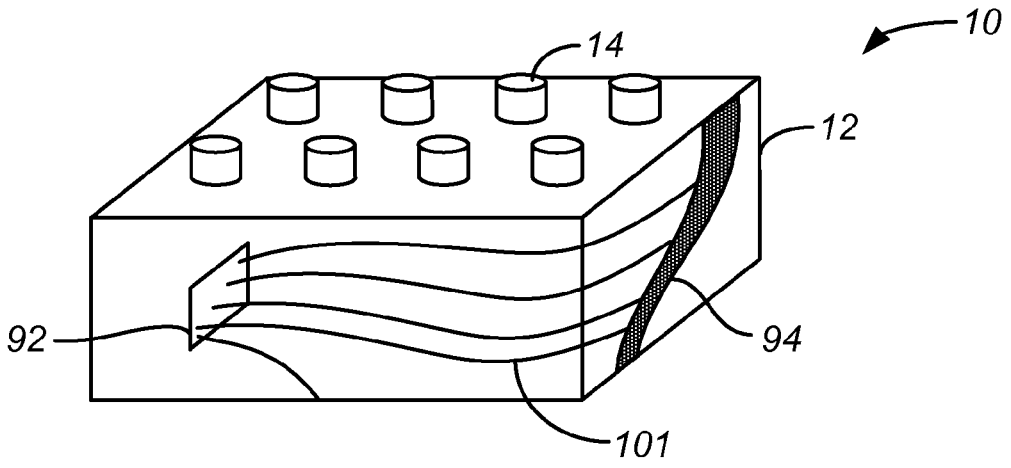
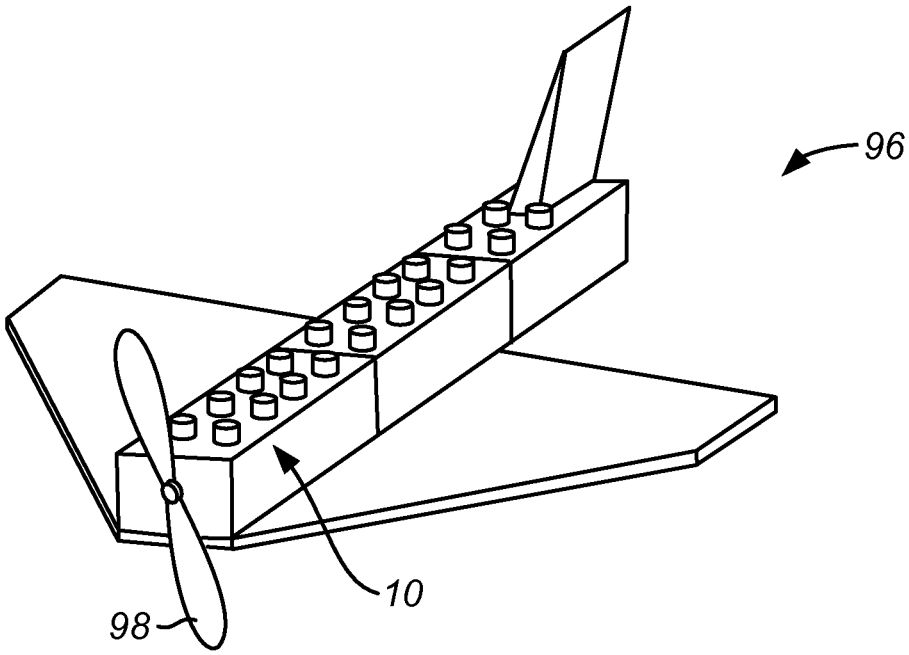


FIG. 22



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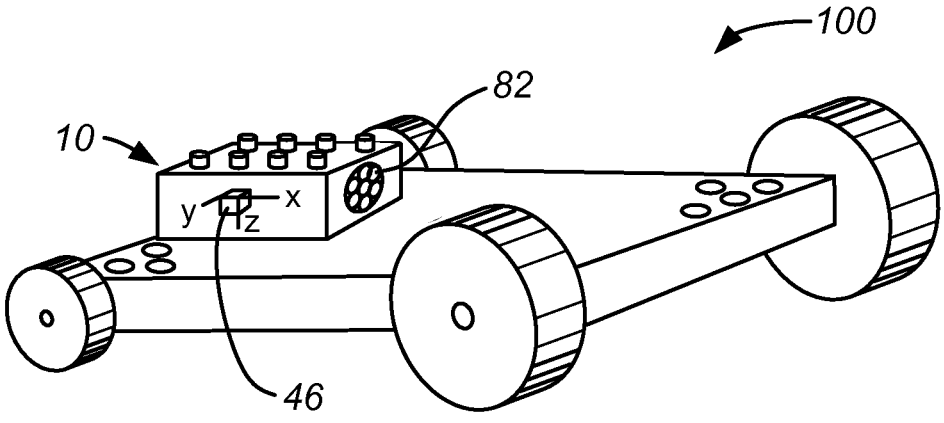
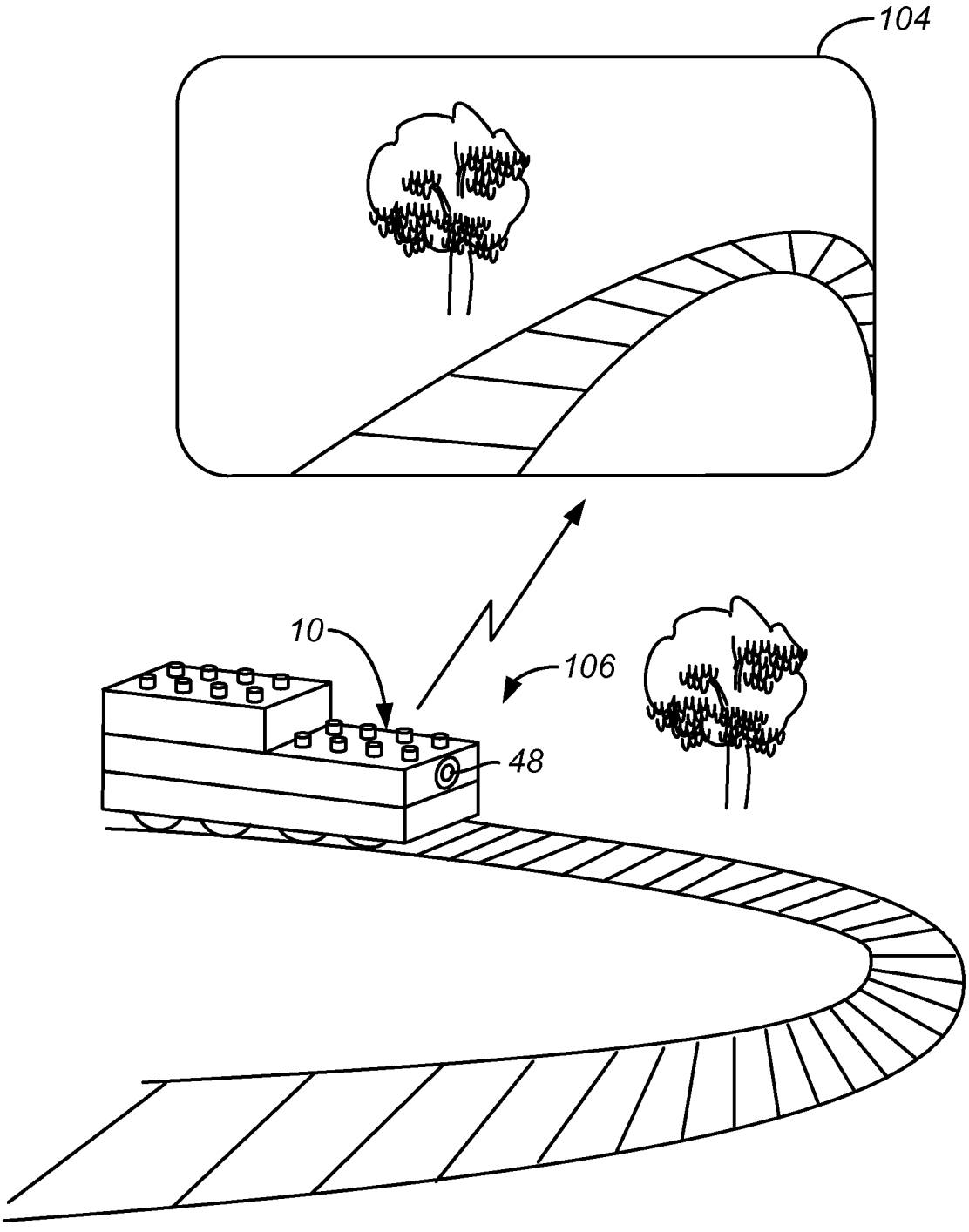


FIG. 24



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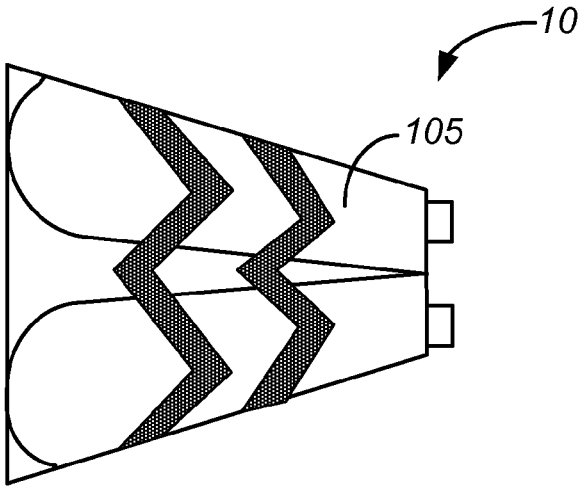

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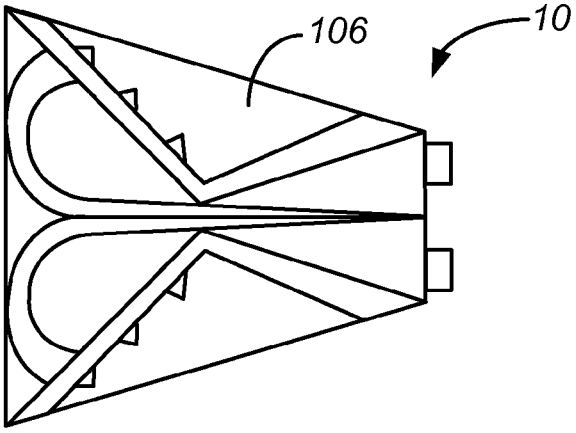

FIG. 27

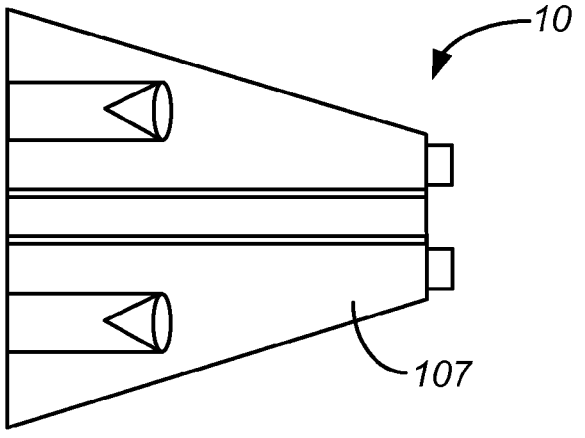

FIG. 28

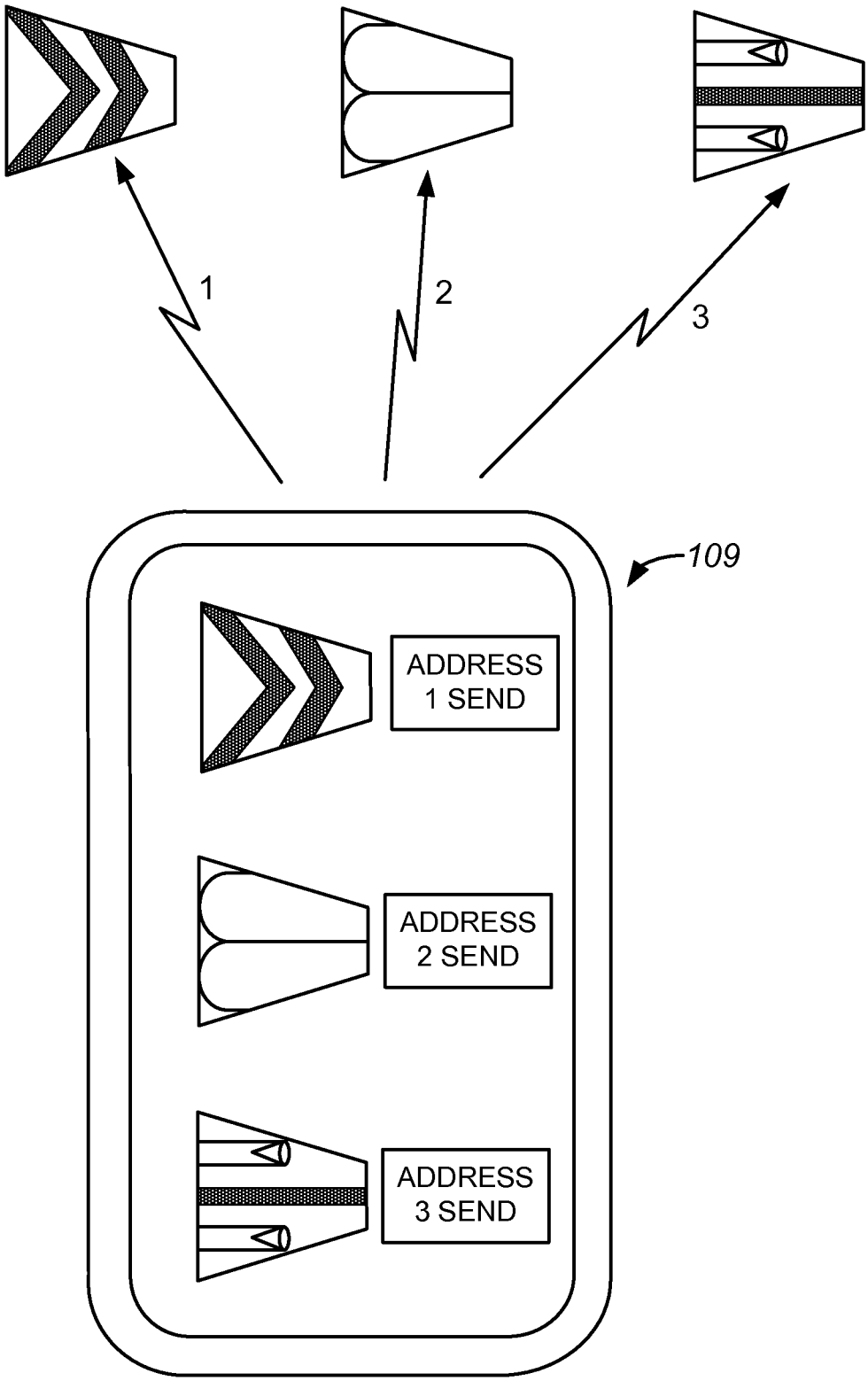

FIG. 29

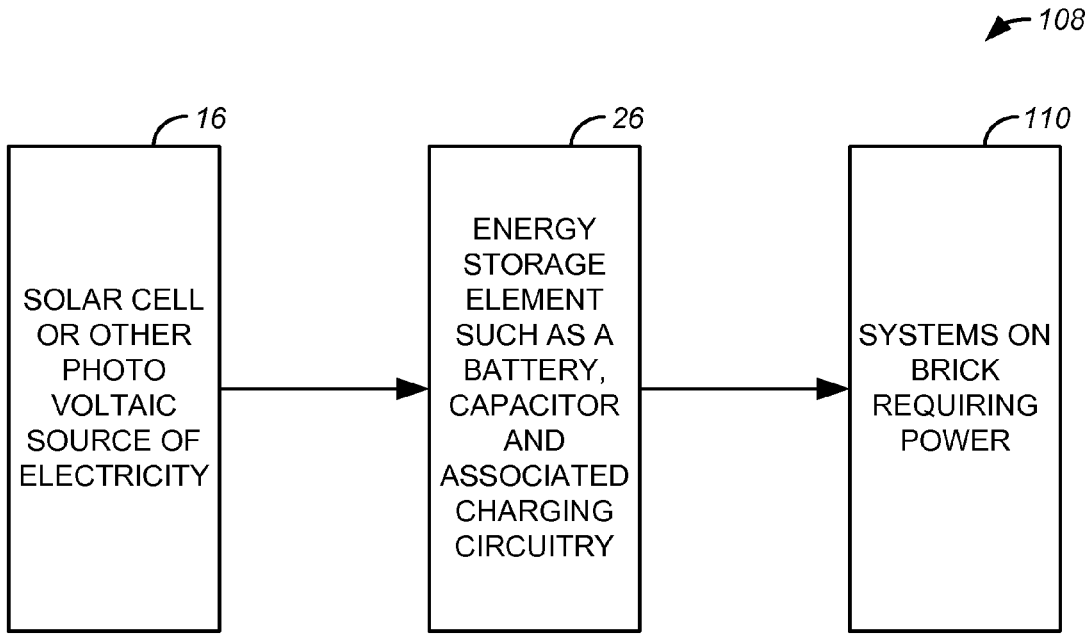
108
16
SOLAR CELL OR OTHER PHOTO VOLTAIC SOURCE OF ELECTRICITY
26
ENERGY STORAGE ELEMENT SUCH AS A BATTERY, CAPACITOR AND ASSOCIATED CHARGING CIRCUITRY
110
SYSTEMS ON BRICK REQUIRING POWER

FIG. 30

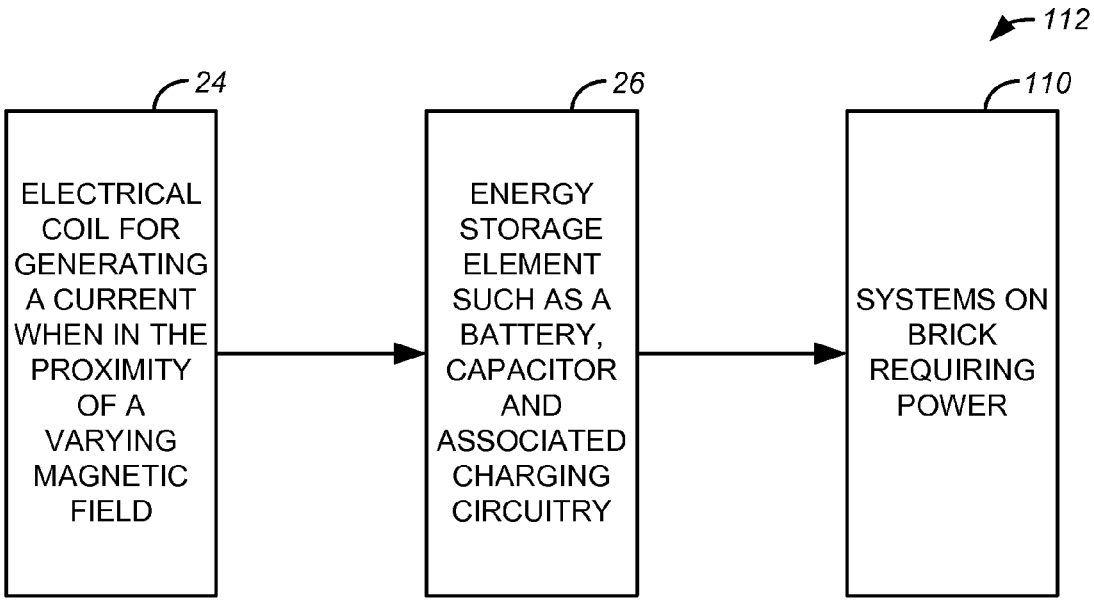
112
24
ELECTRICAL COIL FOR GENERATING A CURRENT WHEN IN THE PROXIMITY OF A VARYING MAGNETIC FIELD
26
ENERGY STORAGE ELEMENT SUCH AS A BATTERY, CAPACITOR AND ASSOCIATED CHARGING CIRCUITRY
110
SYSTEMS ON BRICK REQUIRING POWER

FIG. 31

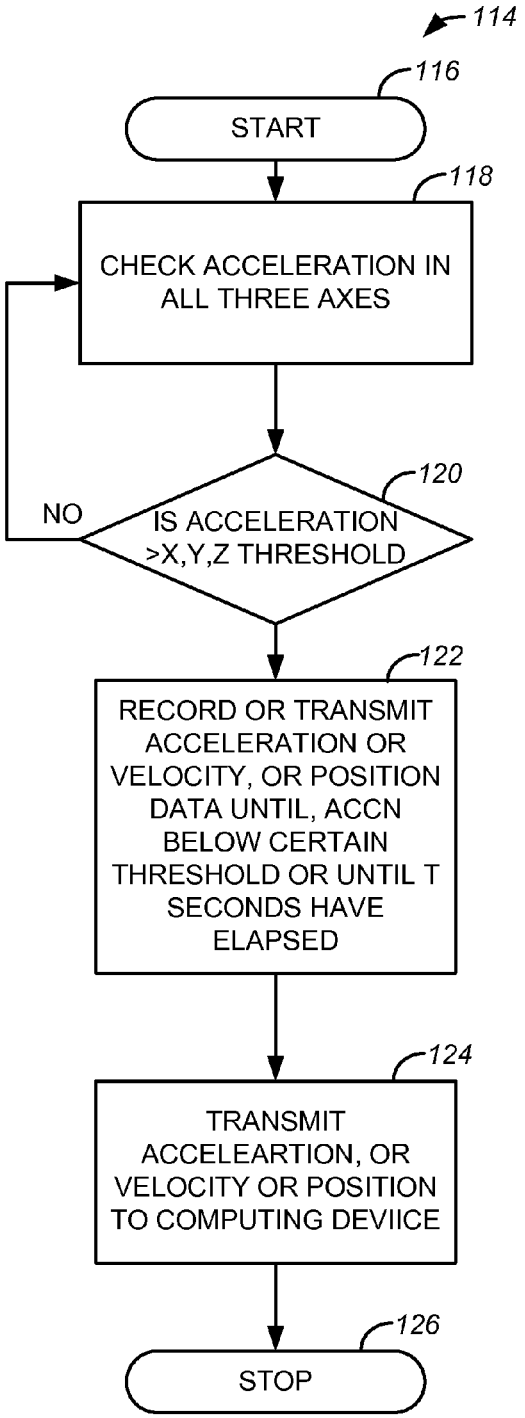
114
116
START
118
CHECK ACCELERATION IN ALL THREE AXES
120
NO
IS ACCELERATION >X,Y,Z THRESHOLD
122
RECORD OR TRANSMIT ACCELERATION OR VELOCITY, OR POSITION DATA UNTIL, ACCN BELOW CERTAIN THRESHOLD OR UNTIL T SECONDS HAVE ELAPSED
124
TRANSMIT ACCELEARTION, OR VELOCITY OR POSITION TO COMPUTING DEVIICE
126
STOP

FIG. 32

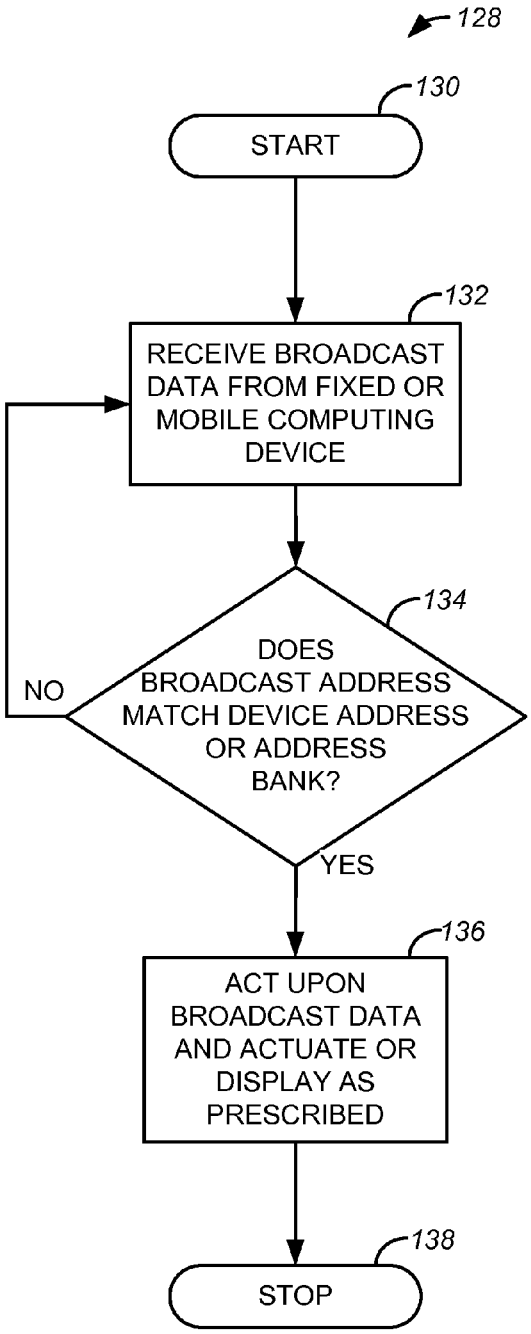
128
130
START
132
RECEIVE BROADCAST DATA FROM FIXED OR MOBILE COMPUTING DEVICE
134
NO
DOES BROADCAST ADDRESS MATCH DEVICE ADDRESS OR ADDRESS BANK?
YES
136
ACT UPON BROADCAST DATA AND ACTUATE OR DISPLAY AS PRESCRIBED
138
STOP

FIG. 33

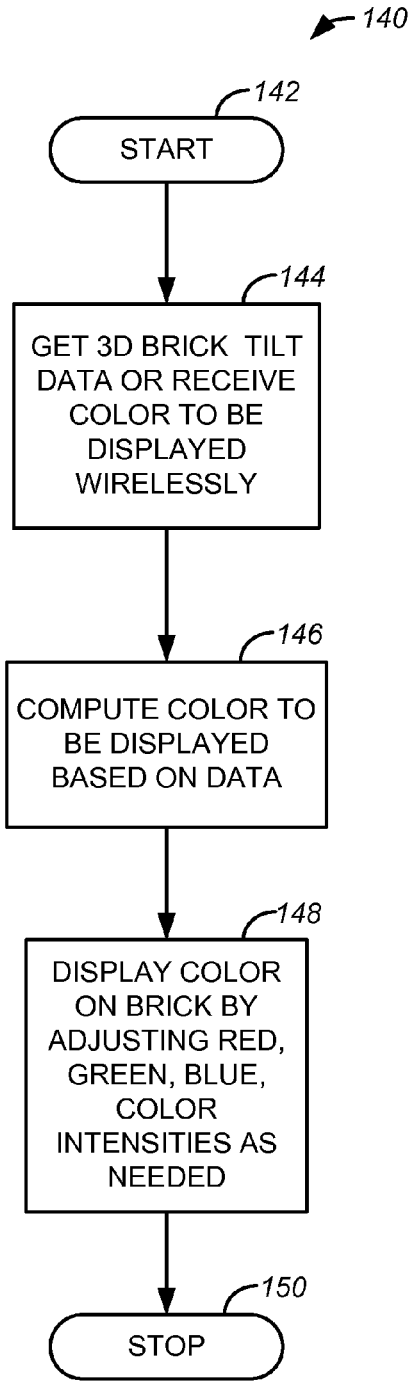
140
142
START
144
GET 3D BRICK TILT DATA OR RECEIVE COLOR TO BE DISPLAYED WIRELESSLY
146
COMPUTE COLOR TO BE DISPLAYED BASED ON DATA
148
DISPLAY COLOR ON BRICK BY ADJUSTING RED, GREEN, BLUE, COLOR INTENSITIES AS NEEDED
150
STOP

FIG. 34

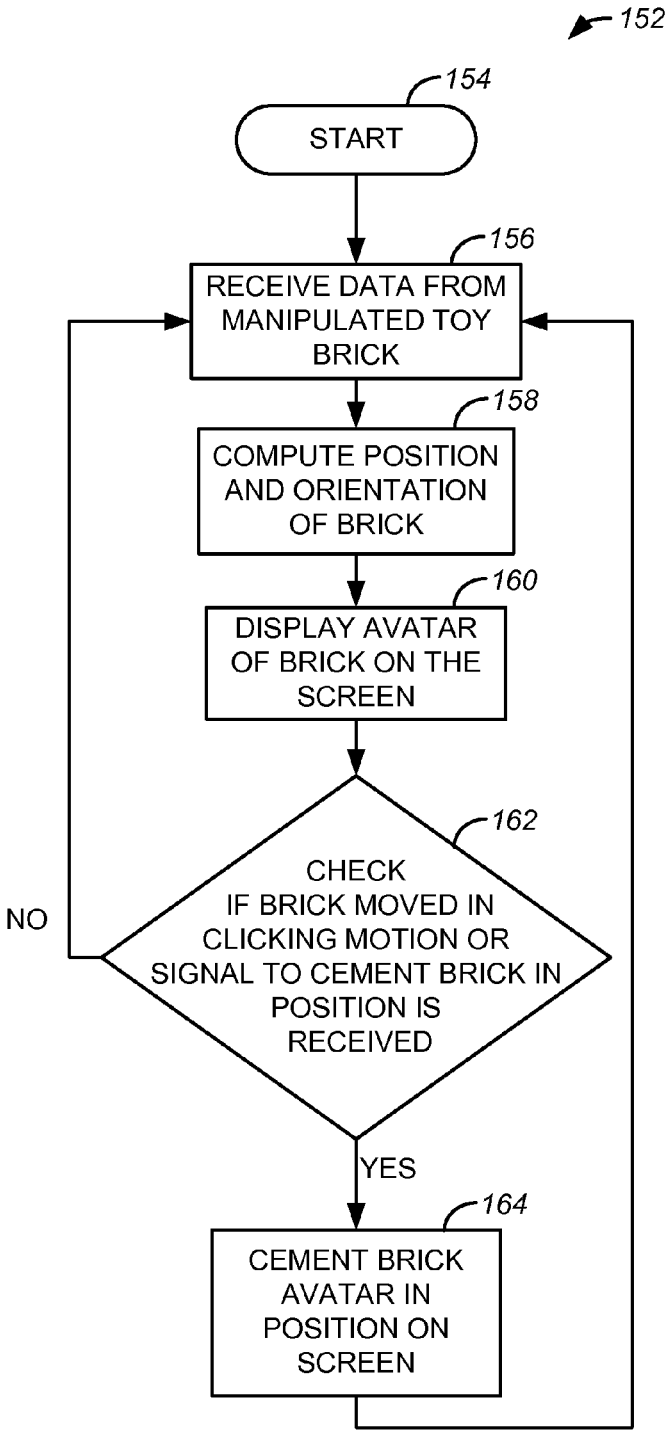
152
154
START
156
RECEIVE DATA FROM MANIPULATED TOY BRICK
158
COMPUTE POSITION AND ORIENTATION OF BRICK
160
DISPLAY AVATAR OF BRICK ON THE SCREEN
162
CHECK IF BRICK MOVED IN CLICKING MOTION OR SIGNAL TO CEMENT BRICK IN POSITION IS RECEIVED
NO
YES
164
CEMENT BRICK AVATAR IN POSITION ON SCREEN

FIG. 35

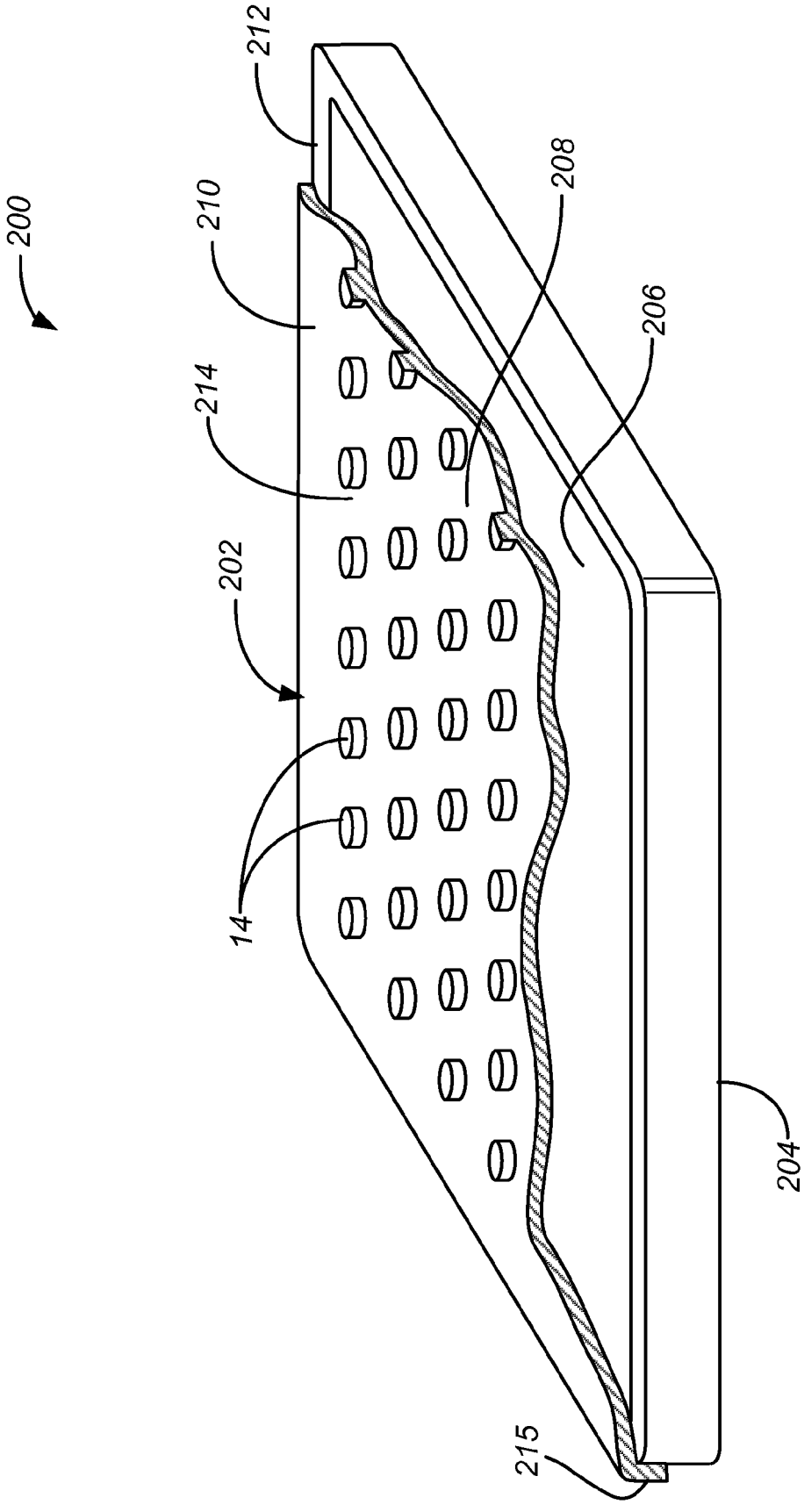

FIG. 36

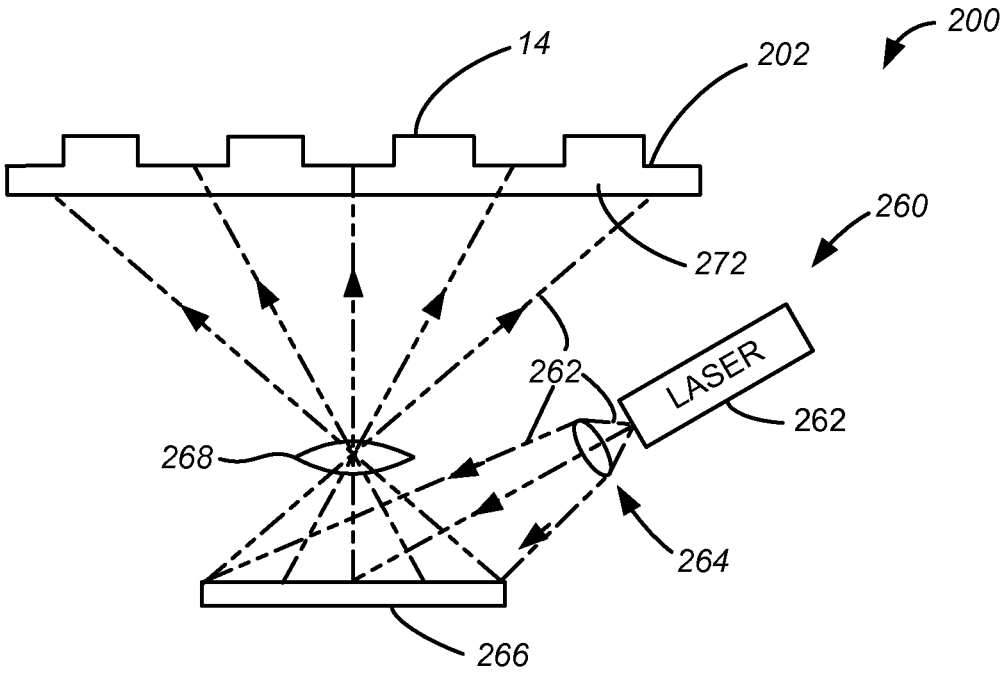

FIG. 37

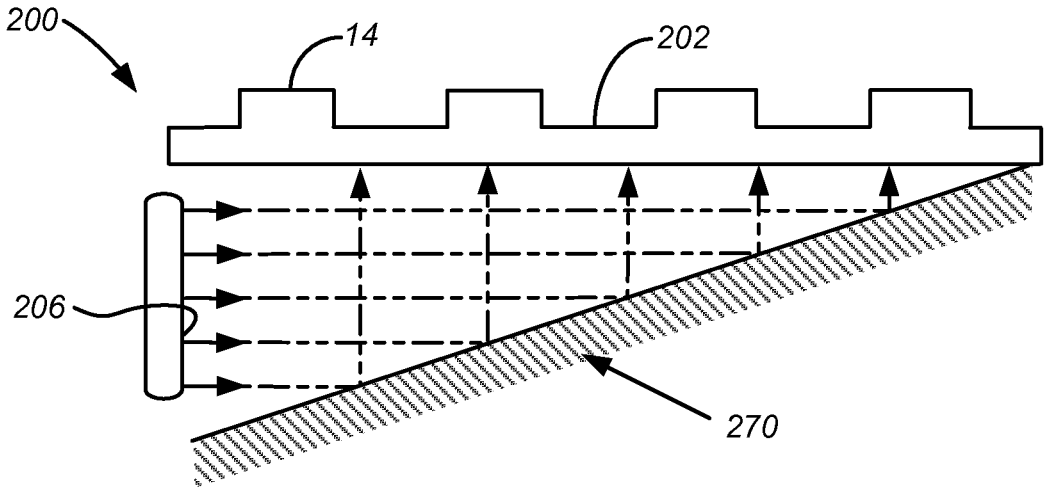

FIG. 38

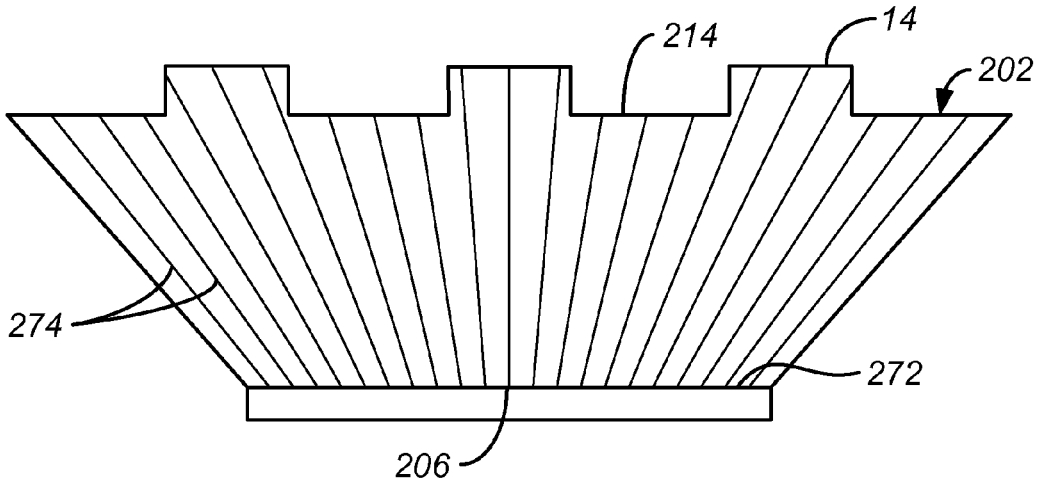

FIG. 39

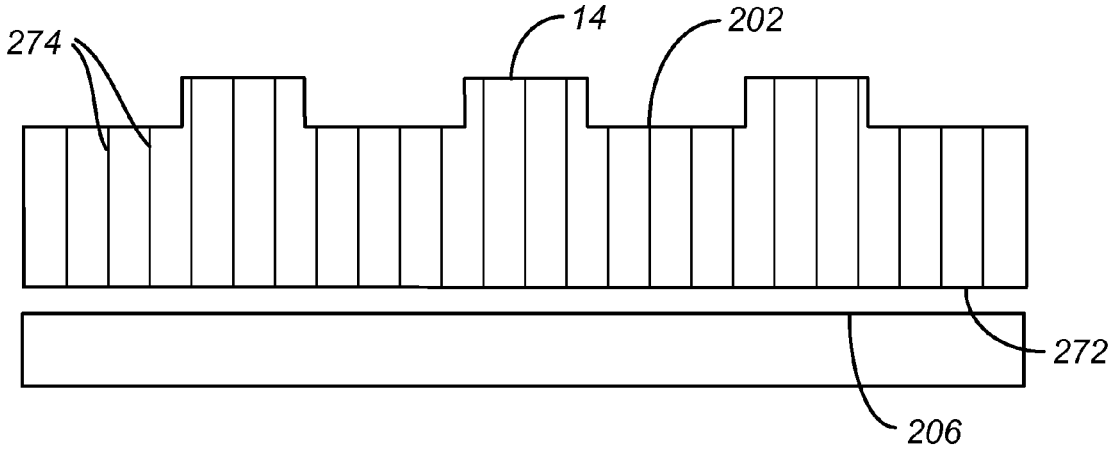

FIG. 40

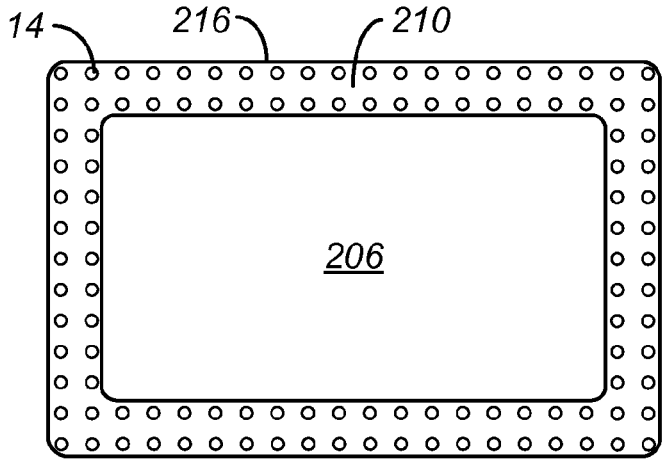

FIG. 41

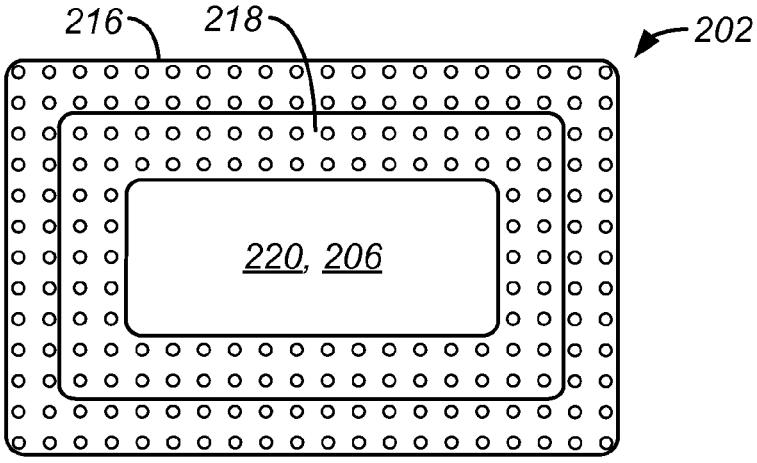

FIG. 42

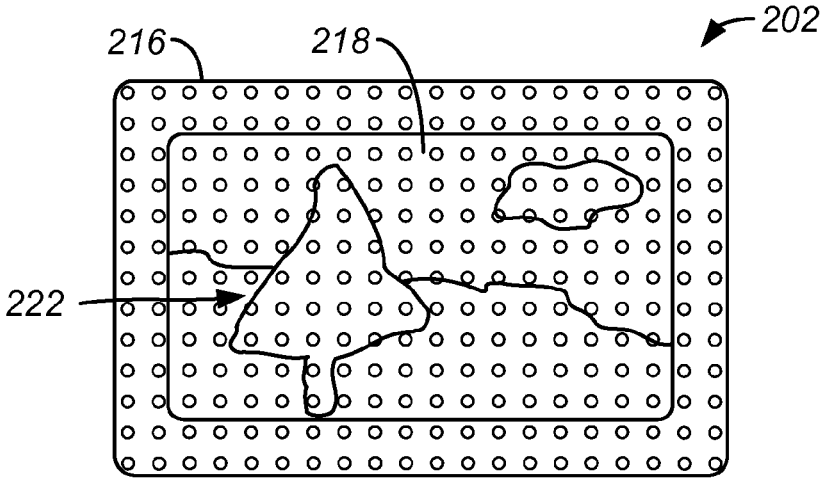

FIG. 43

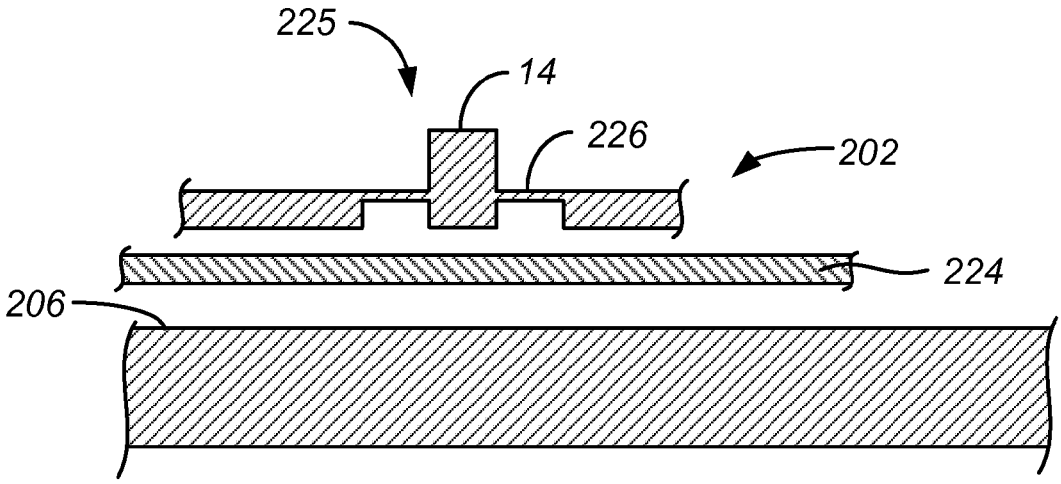

FIG. 44

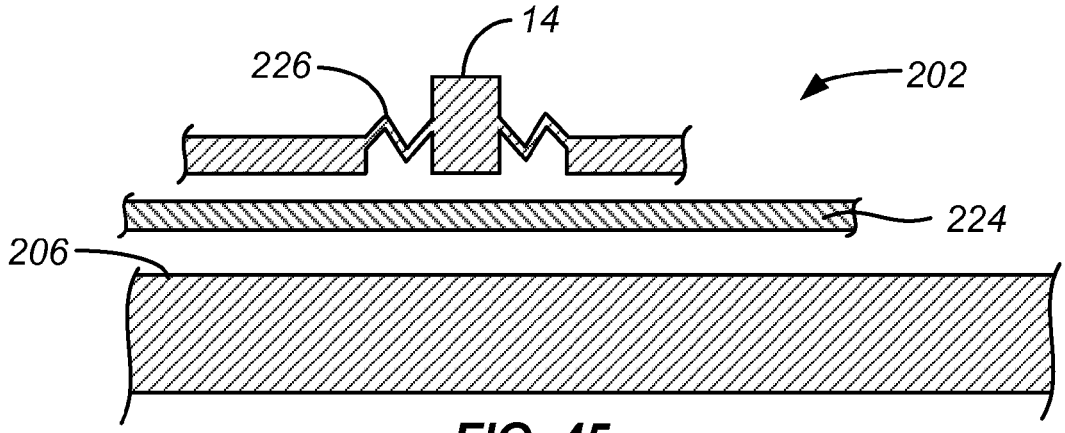

FIG. 45

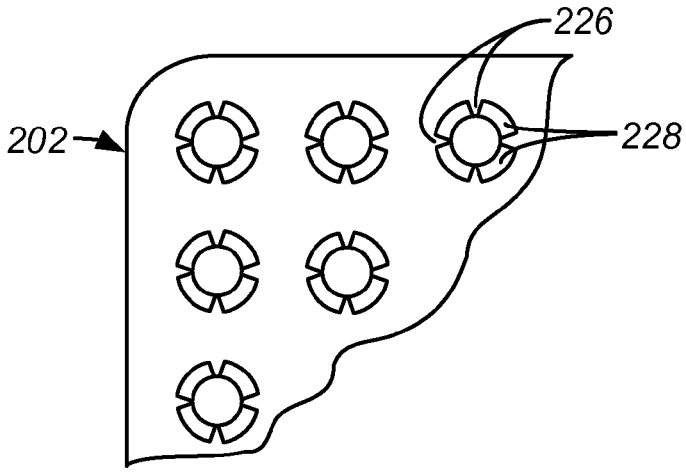

FIG. 46

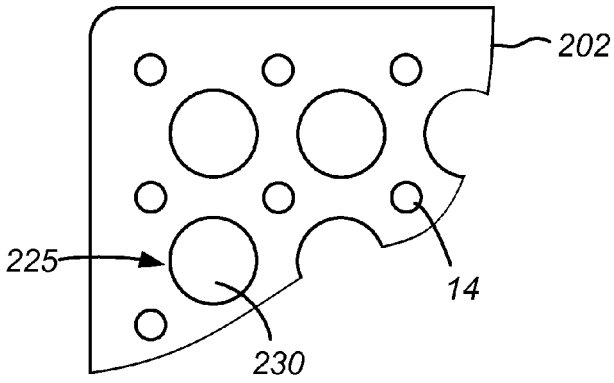

FIG. 47

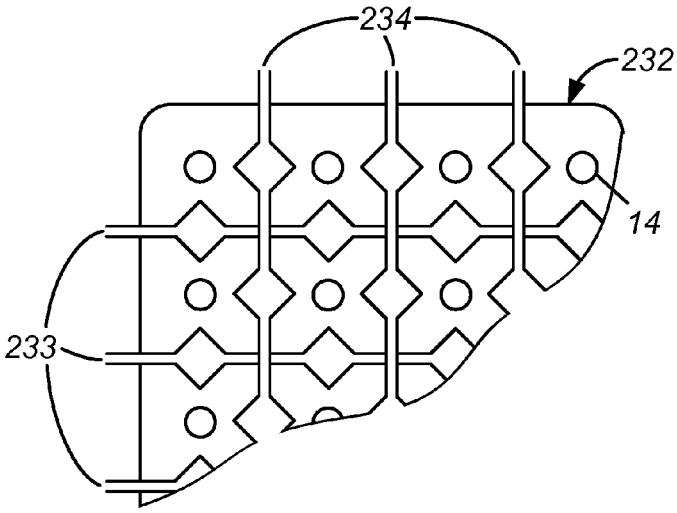

FIG. 48

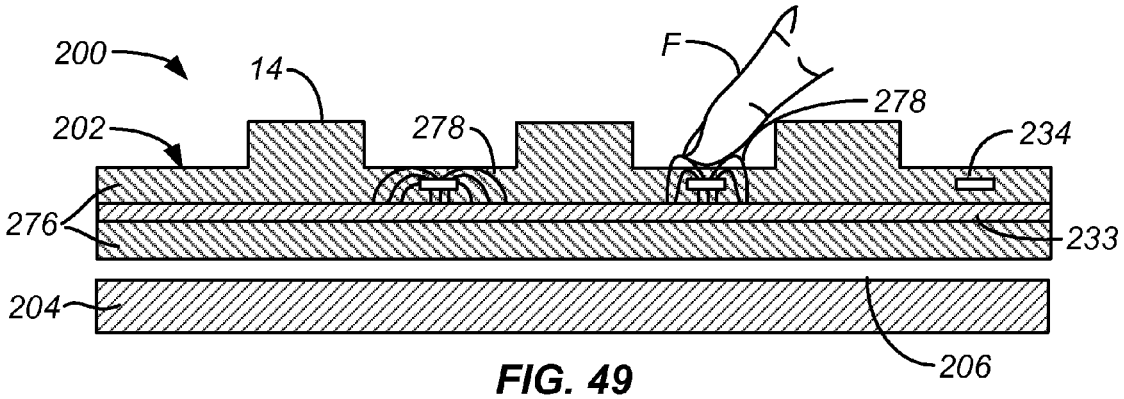

FIG. 49

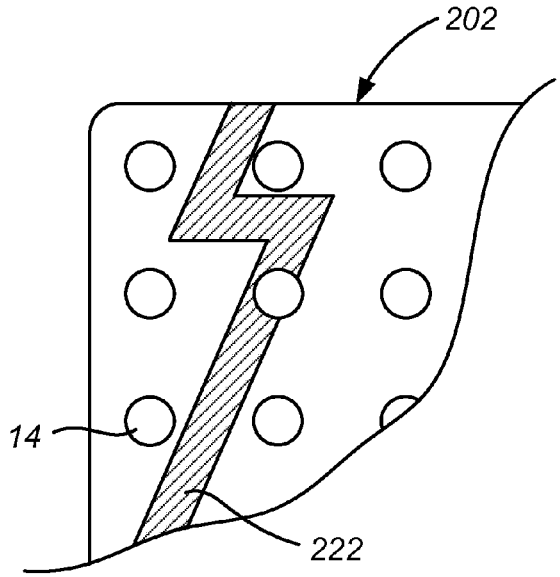

FIG. 50

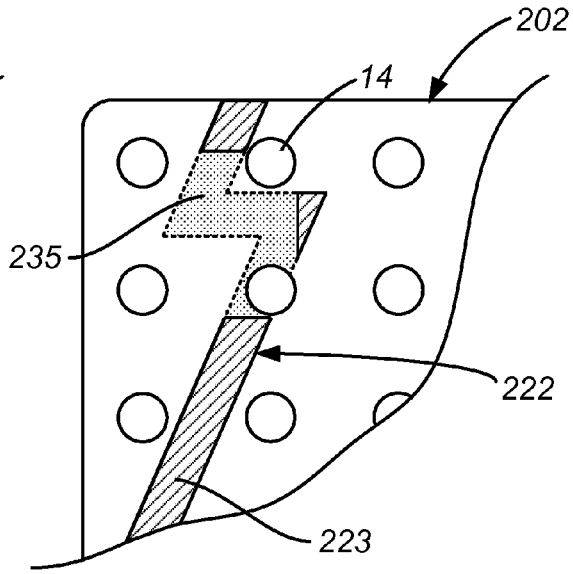

FIG. 51

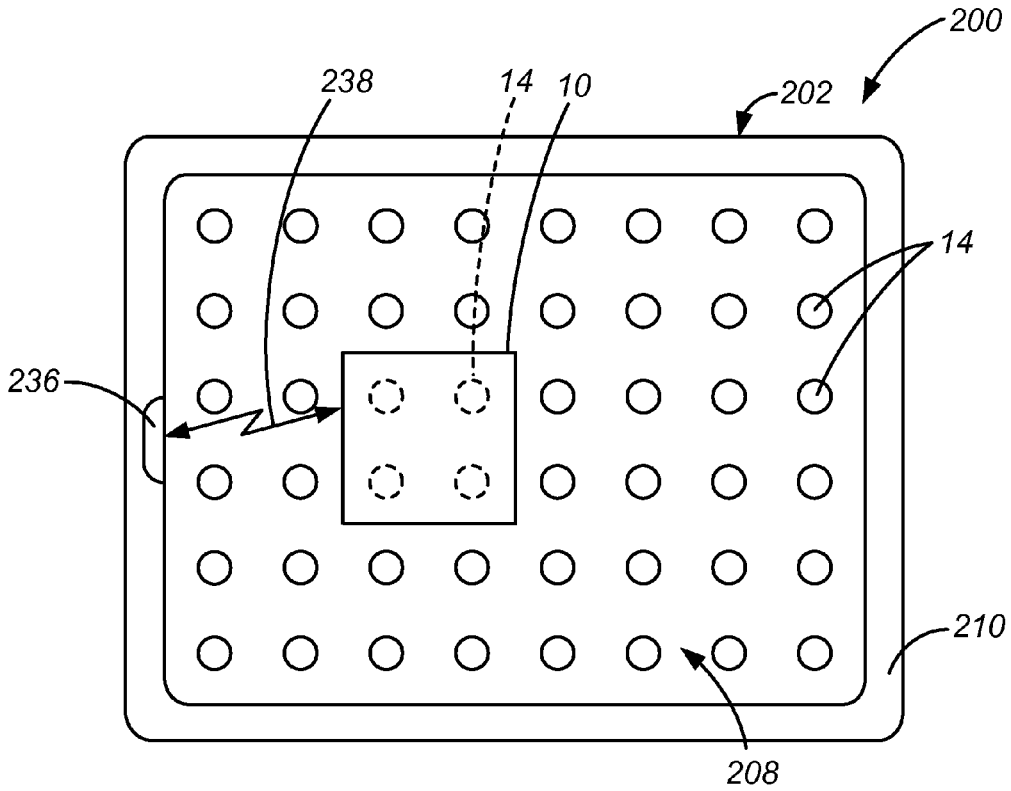

FIG. 52

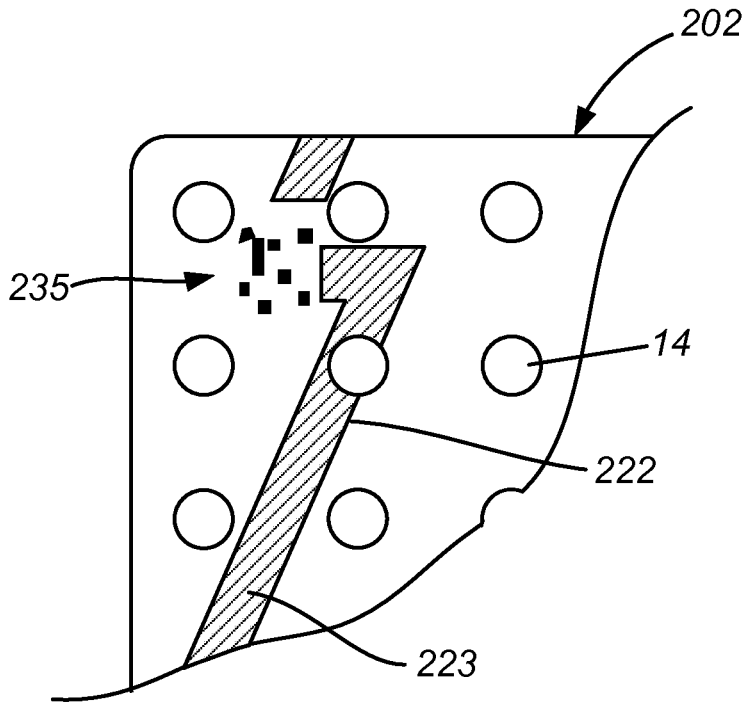

FIG. 53

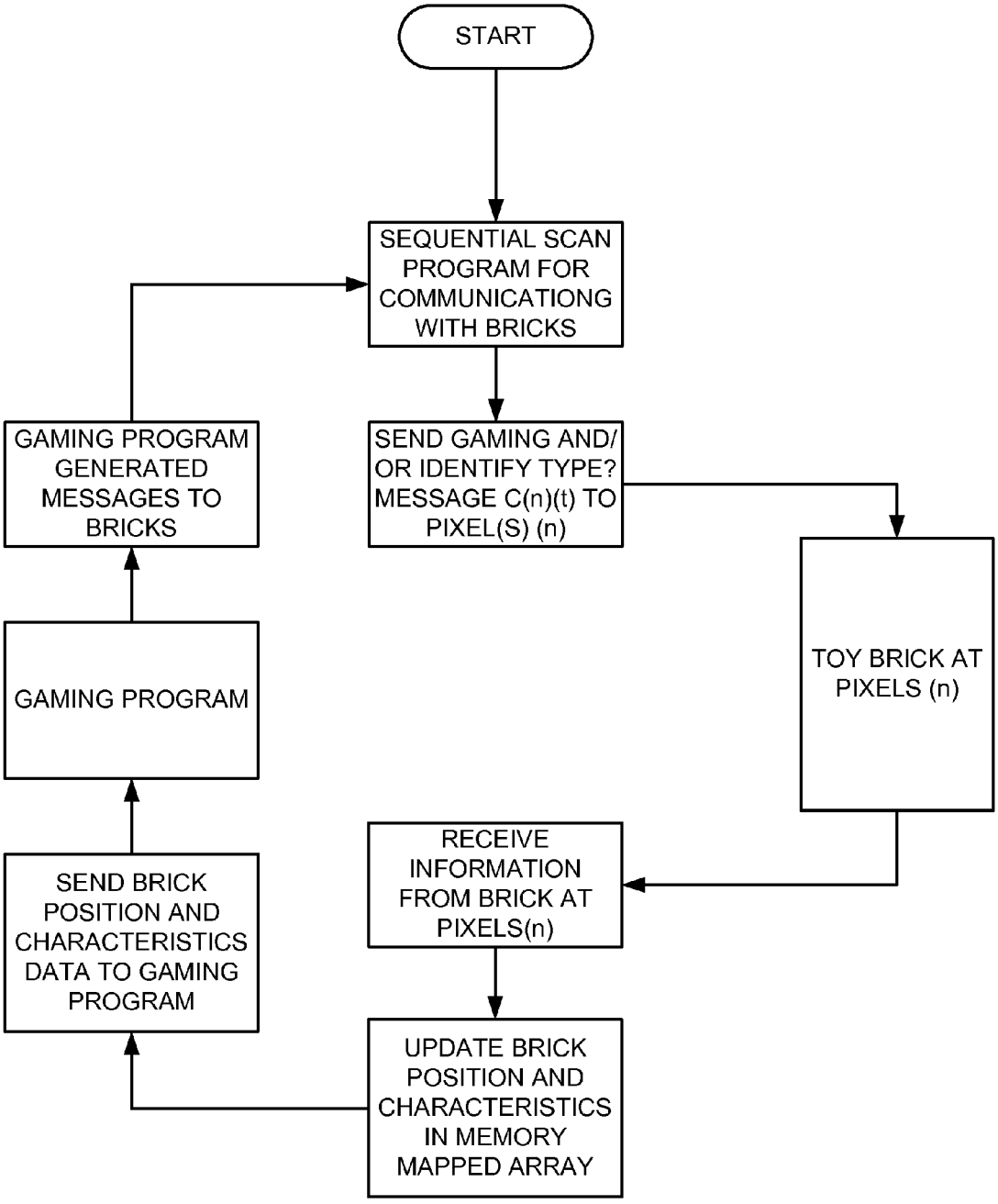
START
SEQUENTIAL SCAN PROGRAM FOR COMMUNICATIONG WITH BRICKS
SEND GAMING AND/ OR IDENTIFY TYPE? MESSAGE C(n)(t) TO PIXEL(S) (n)
TOY BRICK AT PIXELS (n)
RECEIVE INFORMATION FROM BRICK AT PIXELS(n)
UPDATE BRICK POSITION AND CHARACTERISTICS IN MEMORY MAPPED ARRAY
SEND BRICK POSITION AND CHARACTERISTICS DATA TO GAMING PROGRAM
GAMING PROGRAM
GAMING PROGRAM GENERATED MESSAGES TO BRICKS

FIG. 54

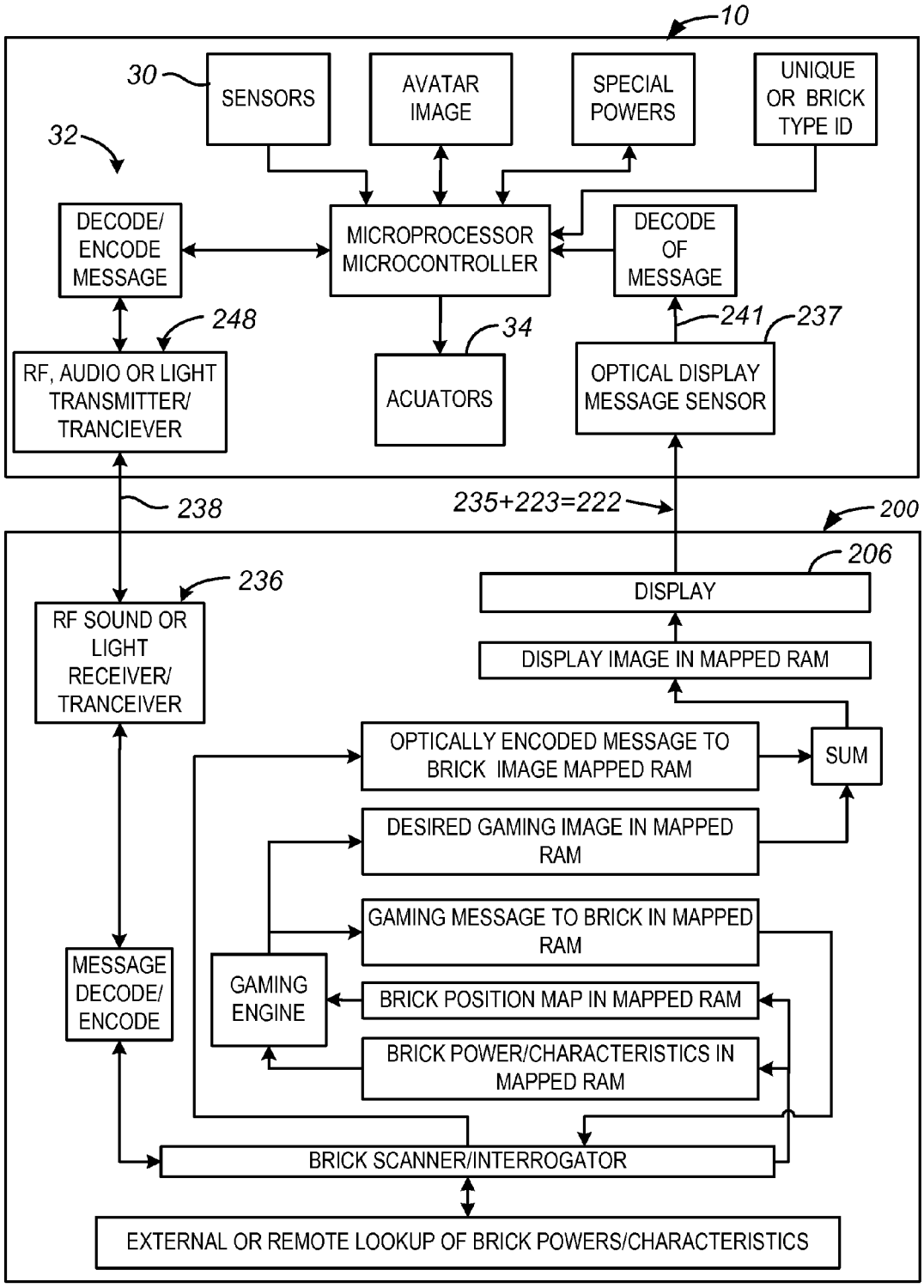
10
30
SENSORS
AVATAR IMAGE
SPECIAL POWERS
UNIQUE OR BRICK TYPE ID
32
DECODE/ ENCODE MESSAGE
MICROPROCESSOR MICROCONTROLLER
DECODE OF MESSAGE
248
34
241
237
RF, AUDIO OR LIGHT TRANSMITTER/ TRANCIEVER
ACUATORS
OPTICAL DISPLAY MESSAGE SENSOR
238
235+223=222
200
206
236
DISPLAY
RF SOUND OR LIGHT RECEIVER/ TRANCEIVER
DISPLAY IMAGE IN MAPPED RAM
OPTICALLY ENCODED MESSAGE TO BRICK IMAGE MAPPED RAM
SUM
DESIRED GAMING IMAGE IN MAPPED RAM
GAMING MESSAGE TO BRICK IN MAPPED RAM
MESSAGE DECODE/ ENCODE
GAMING ENGINE
BRICK POSITION MAP IN MAPPED RAM
BRICK POWER/CHARACTERISTICS IN MAPPED RAM
BRICK SCANNER/INTERROGATOR
EXTERNAL OR REMOTE LOOKUP OF BRICK POWERS/CHARACTERISTICS

FIG. 55

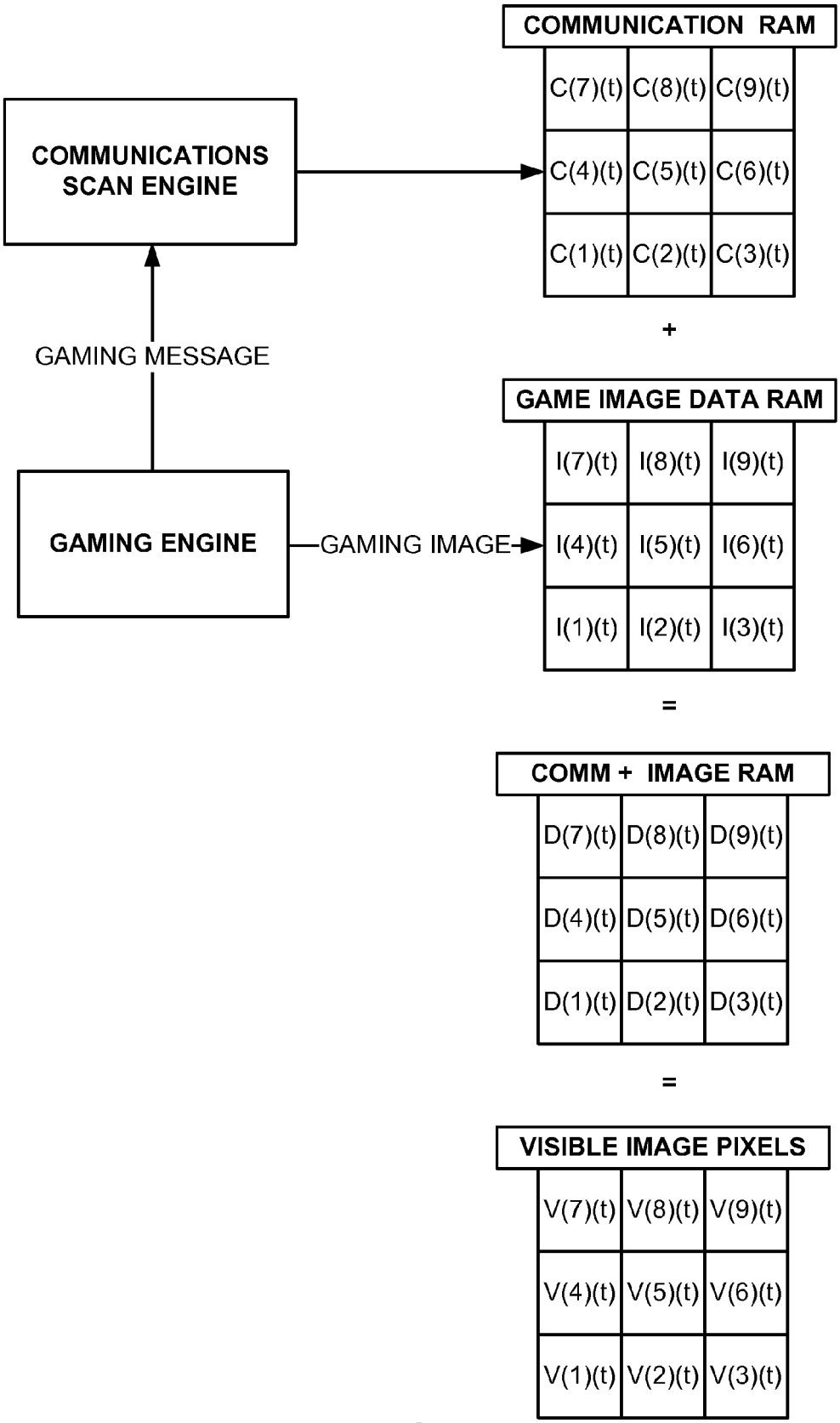
COMMUNICATION RAM
C(7)(t) C(8)(t) C(9)(t)
C(4)(t) C(5)(t) C(6)(t)
C(1)(t) C(2)(t) C(3)(t)
COMMUNICATIONS SCAN ENGINE
+
GAMING MESSAGE
GAME IMAGE DATA RAM
I(7)(t) I(8)(t) I(9)(t)
I(4)(t) I(5)(t) I(6)(t)
I(1)(t) I(2)(t) I(3)(t)
GAMING ENGINE
GAMING IMAGE
=
COMM + IMAGE RAM
D(7)(t) D(8)(t) D(9)(t)
D(4)(t) D(5)(t) D(6)(t)
D(1)(t) D(2)(t) D(3)(t)
=
VISIBLE IMAGE PIXELS
V(7)(t) V(8)(t) V(9)(t)
V(4)(t) V(5)(t) V(6)(t)
V(1)(t) V(2)(t) V(3)(t)

FIG. 56

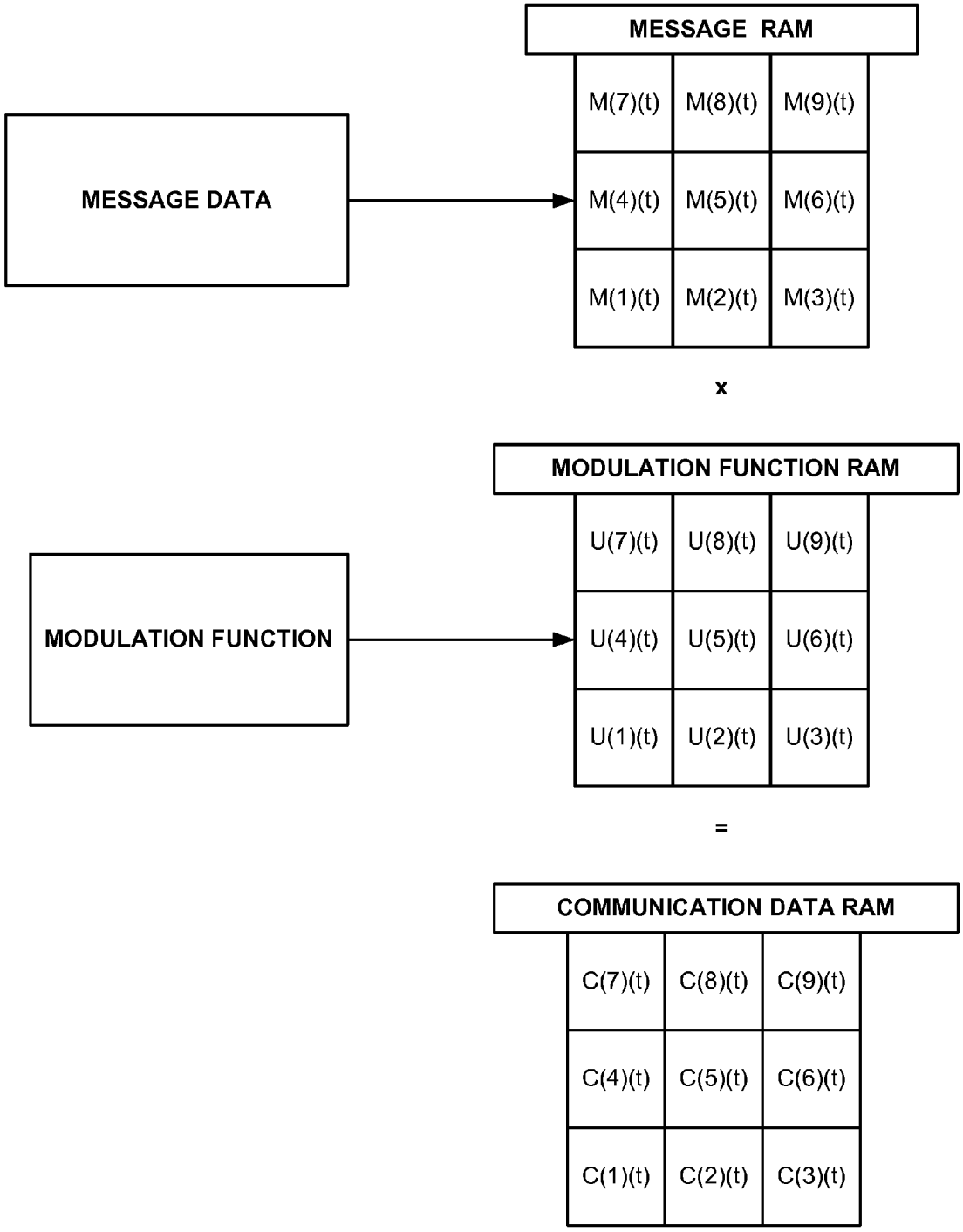
MESSAGE RAM
M(7)(t)
M(8)(t)
M(9)(t)
M(4)(t)
M(5)(t)
M(6)(t)
M(1)(t)
M(2)(t)
M(3)(t)
MESSAGE DATA
x
MODULATION FUNCTION RAM
U(7)(t)
U(8)(t)
U(9)(t)
U(4)(t)
U(5)(t)
U(6)(t)
U(1)(t)
U(2)(t)
U(3)(t)
MODULATION FUNCTION
=
COMMUNICATION DATA RAM
C(7)(t)
C(8)(t)
C(9)(t)
C(4)(t)
C(5)(t)
C(6)(t)
C(1)(t)
C(2)(t)
C(3)(t)

FIG. 57

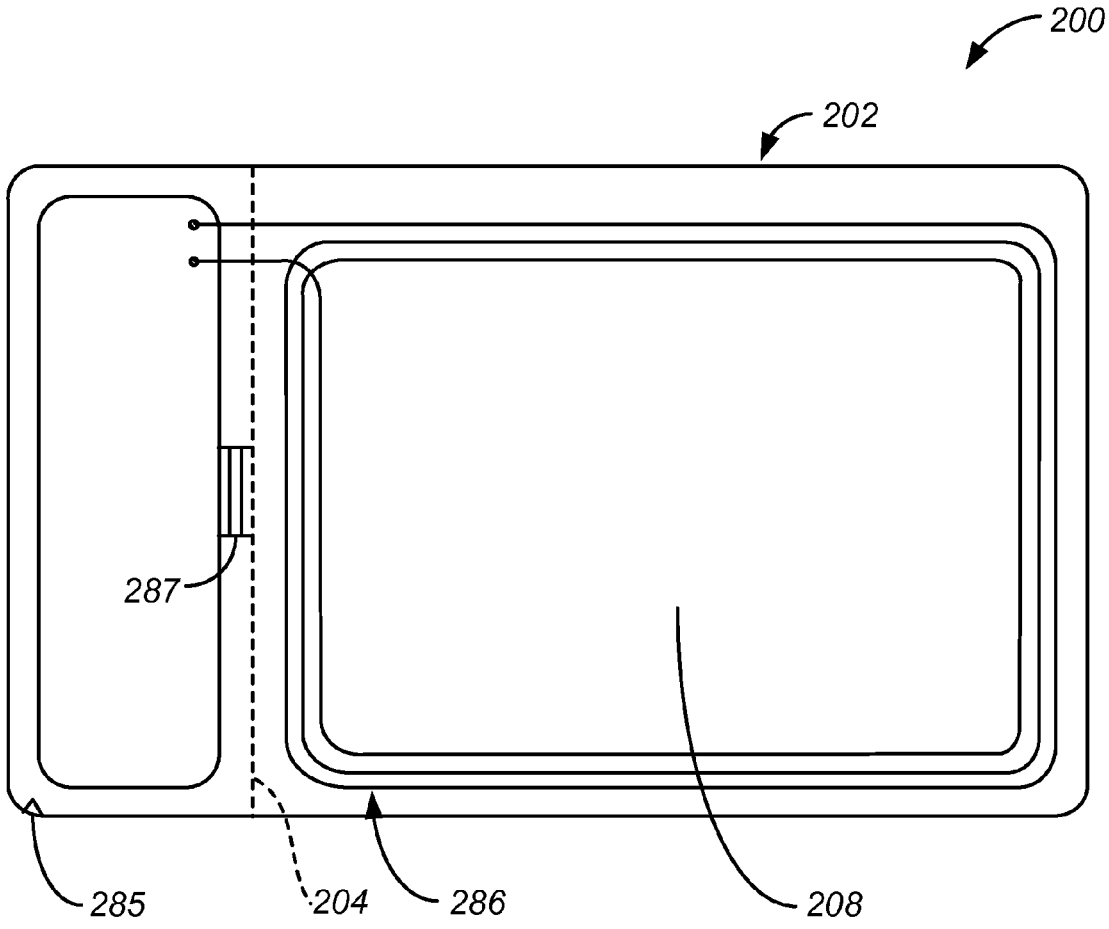

FIG. 58

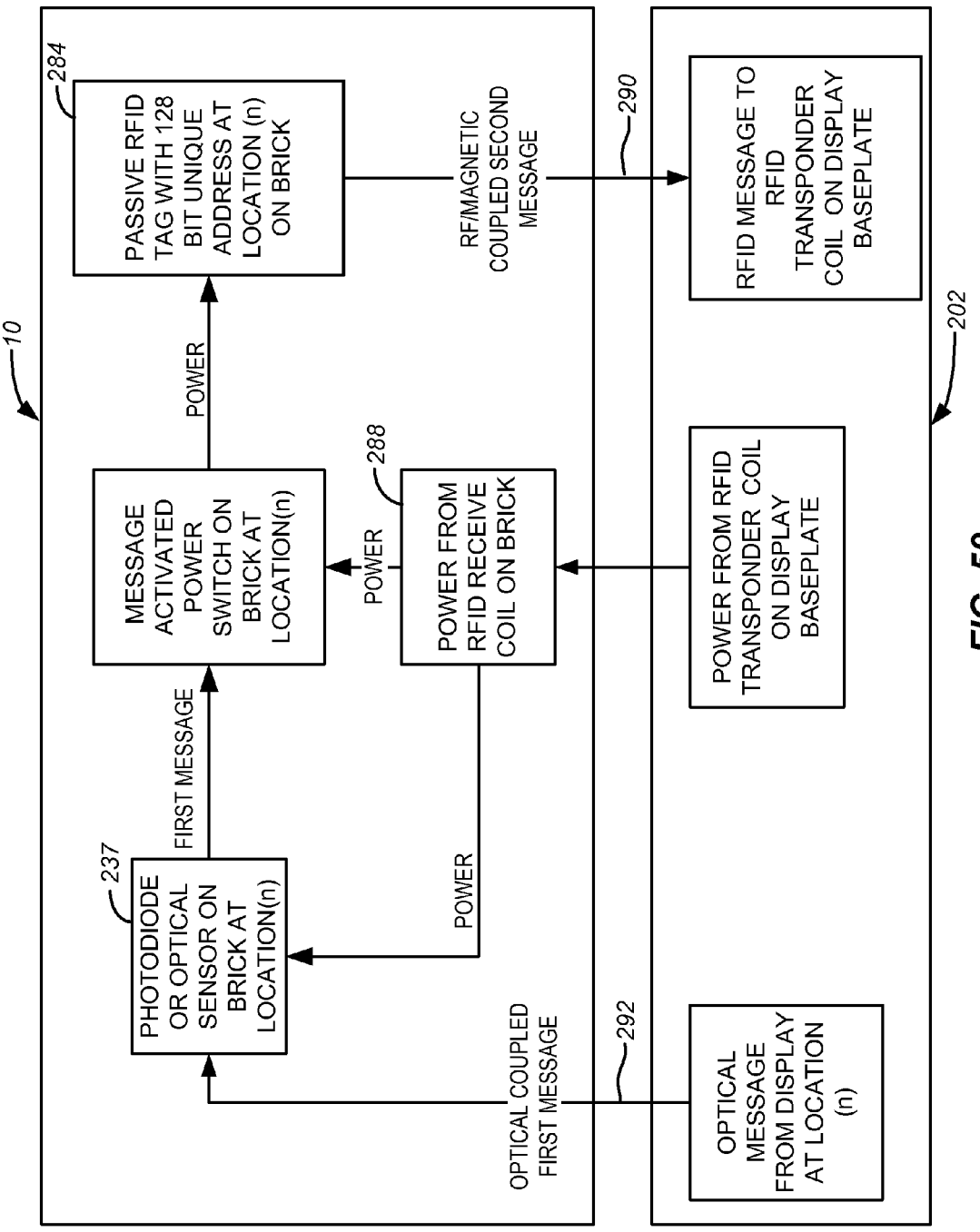
10
284
PASSIVE RFID TAG WITH 128 BIT UNIQUE ADDRESS AT LOCATION (n) ON BRICK
RF/MAGNETIC COUPLED SECOND MESSAGE
290
RFID MESSAGE TO RFID TRANSPONDER COIL ON DISPLAY BASEPLATE
202
POWER
MESSAGE ACTIVATED POWER SWITCH ON BRICK AT LOCATION(n)
288
POWER
POWER FROM RFID RECEIVE COIL ON BRICK
POWER FROM RFID TRANSPONDER COIL ON DISPLAY BASEPLATE
FIRST MESSAGE
237
PHOTODIODE OR OPTICAL SENSOR ON BRICK AT LOCATION(n)
POWER
OPTICAL COUPLED FIRST MESSAGE
292
OPTICAL MESSAGE FROM DISPLAY AT LOCATION (n)

FIG. 59

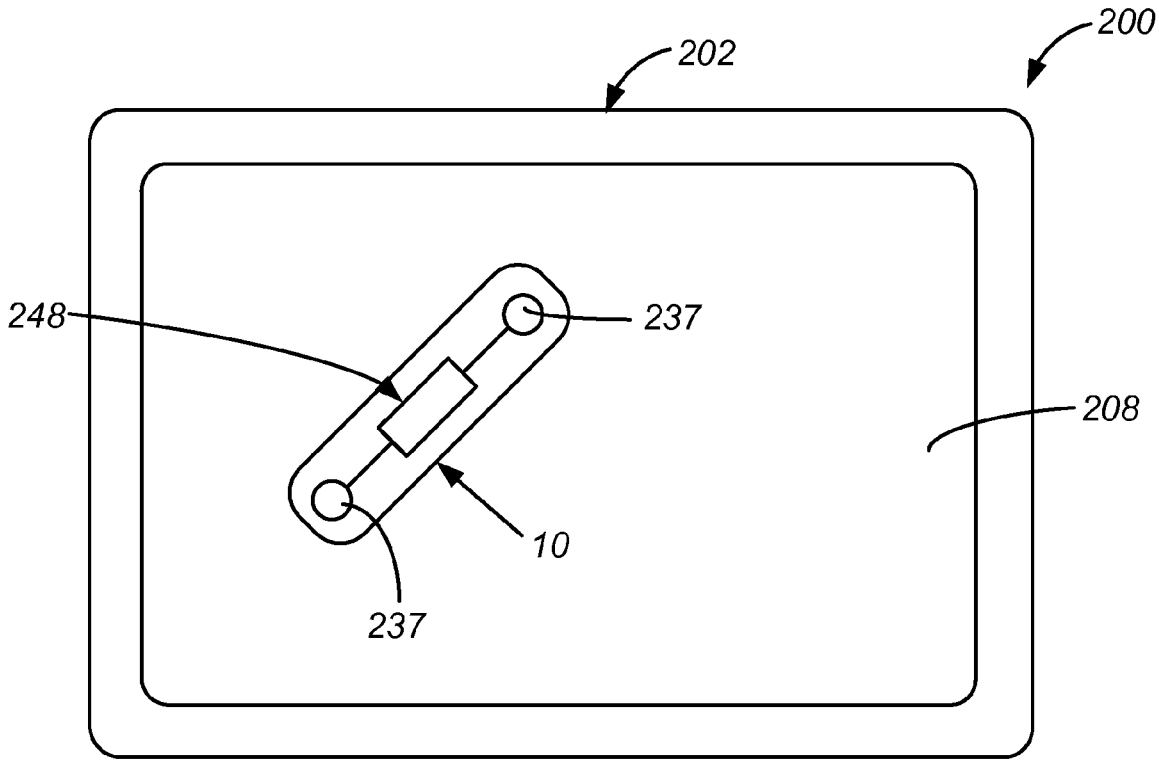

FIG. 60

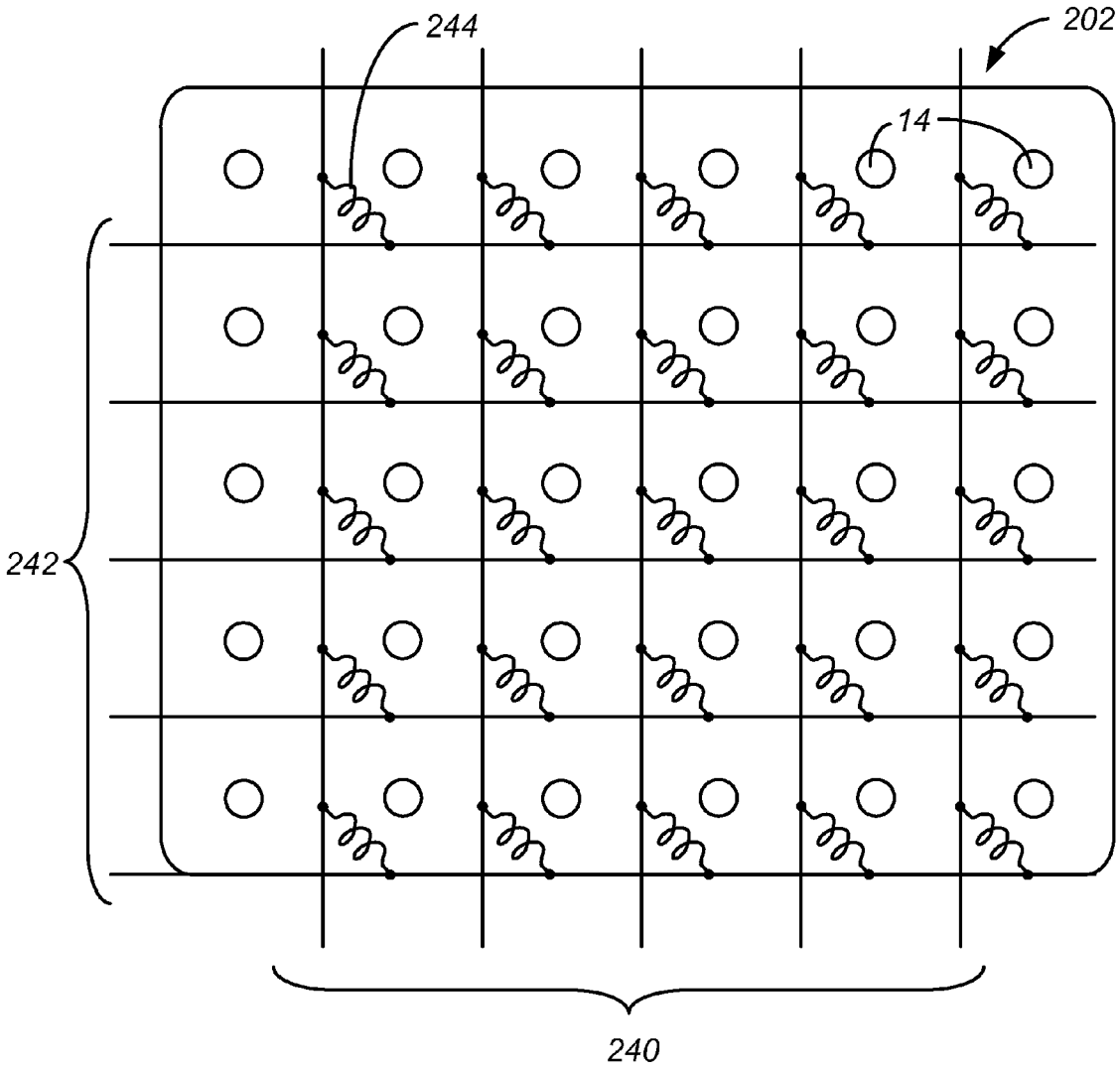

FIG. 61

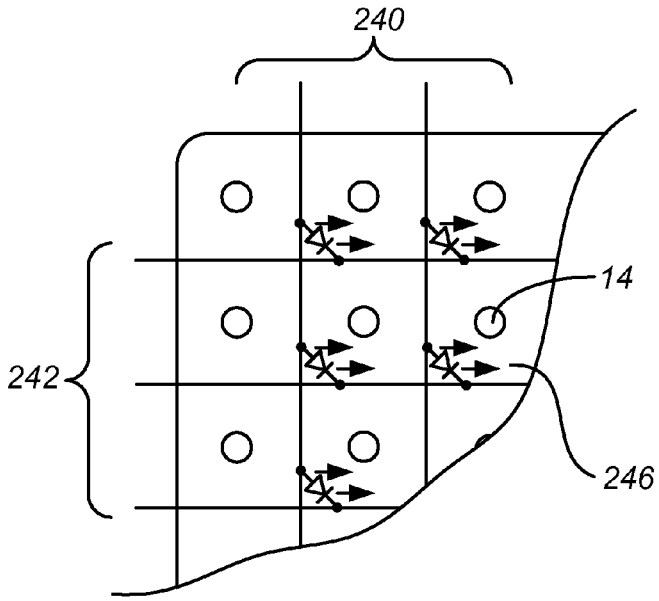

FIG. 62

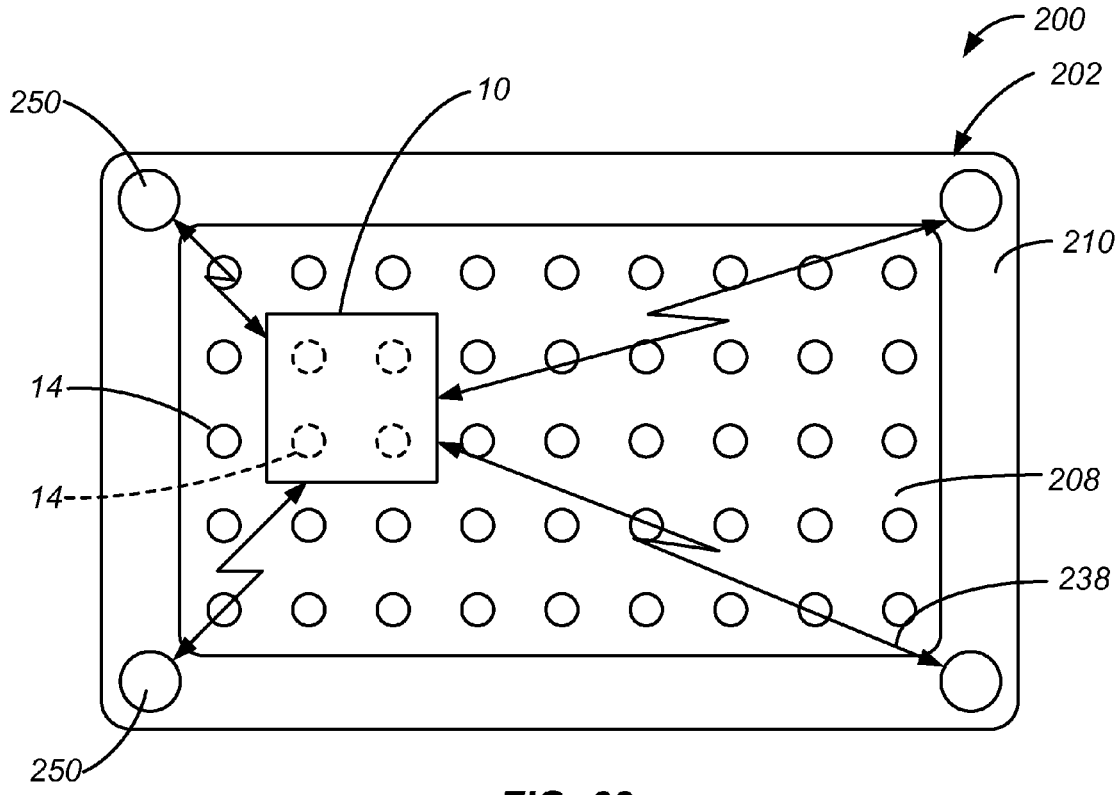

FIG. 63

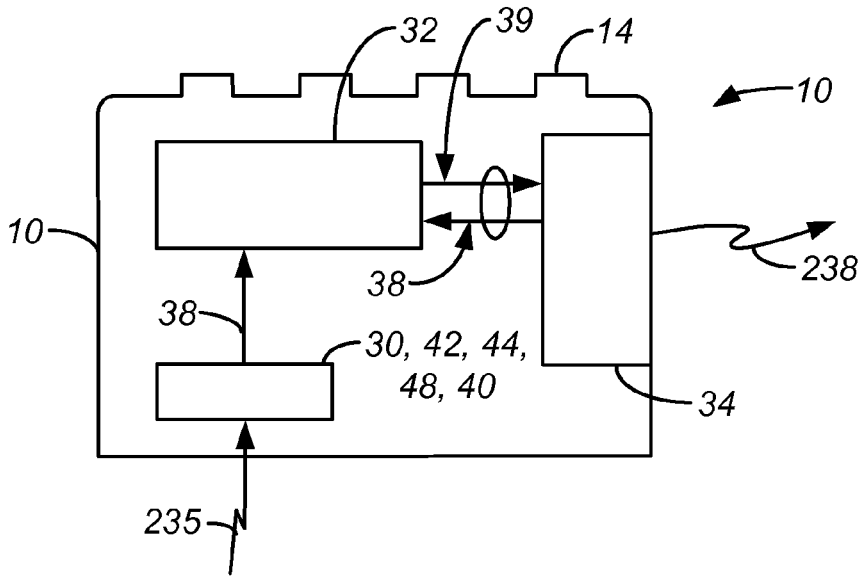

FIG. 64

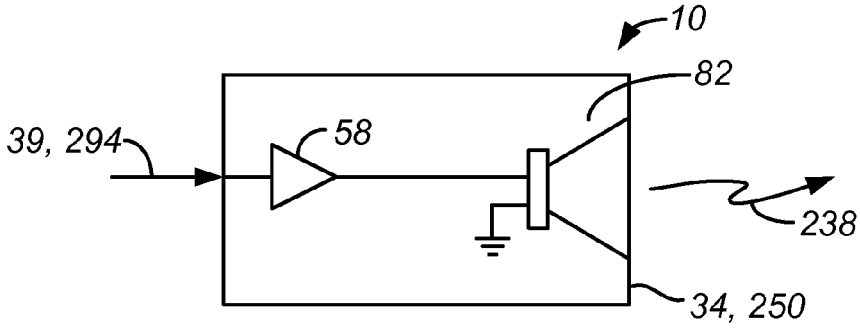

FIG. 65

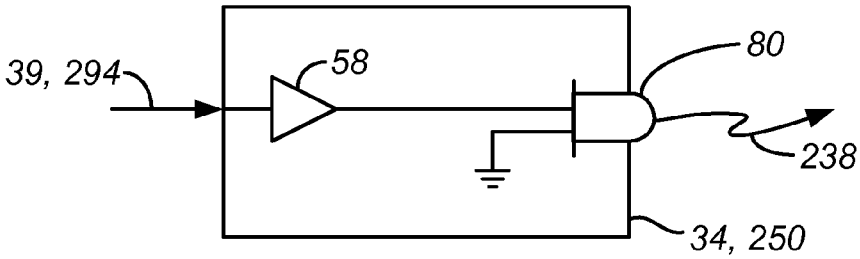

FIG. 66

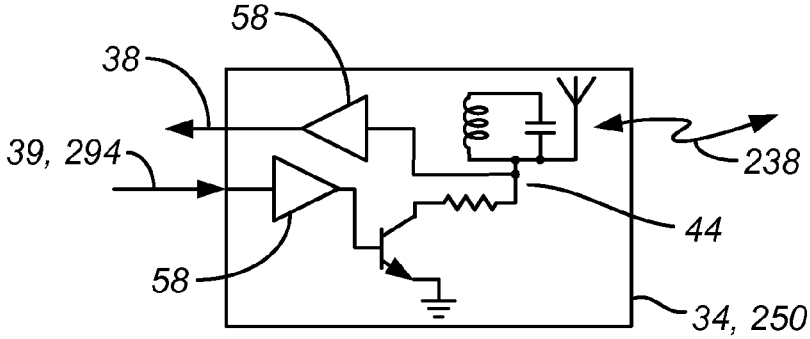

FIG. 67

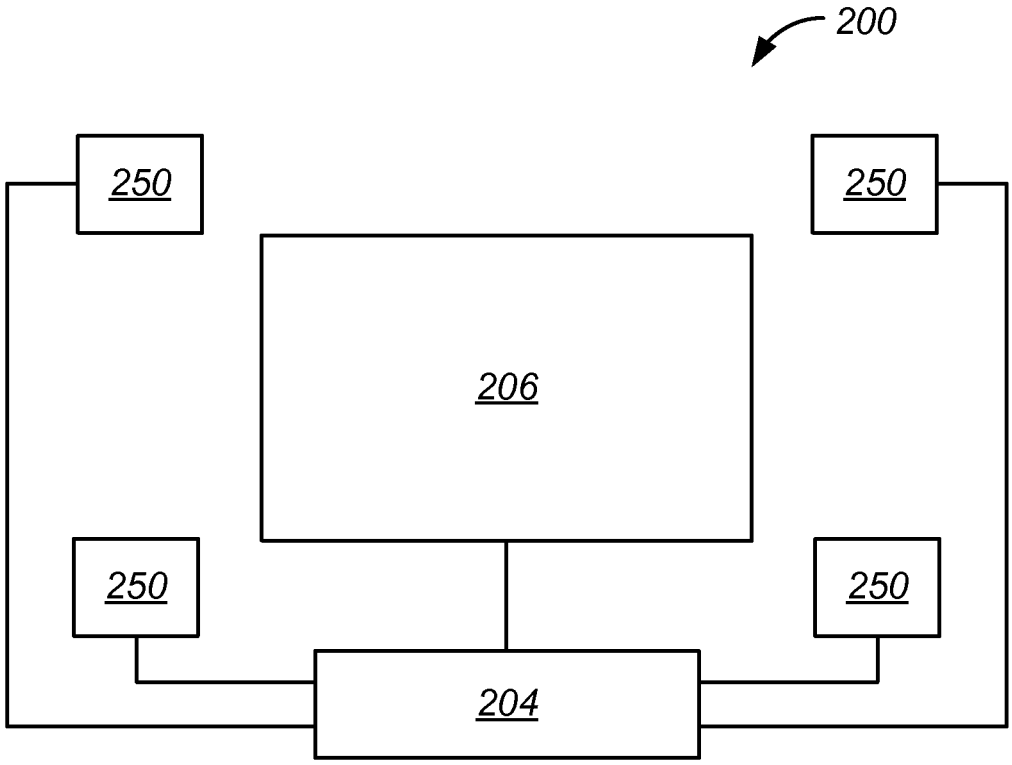

FIG. 68

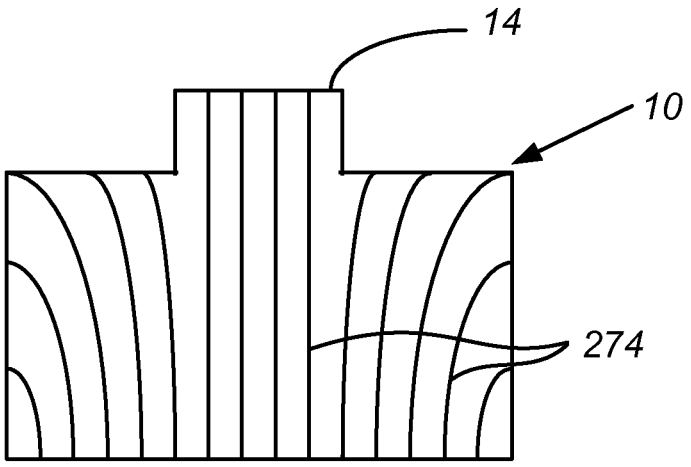

FIG. 69

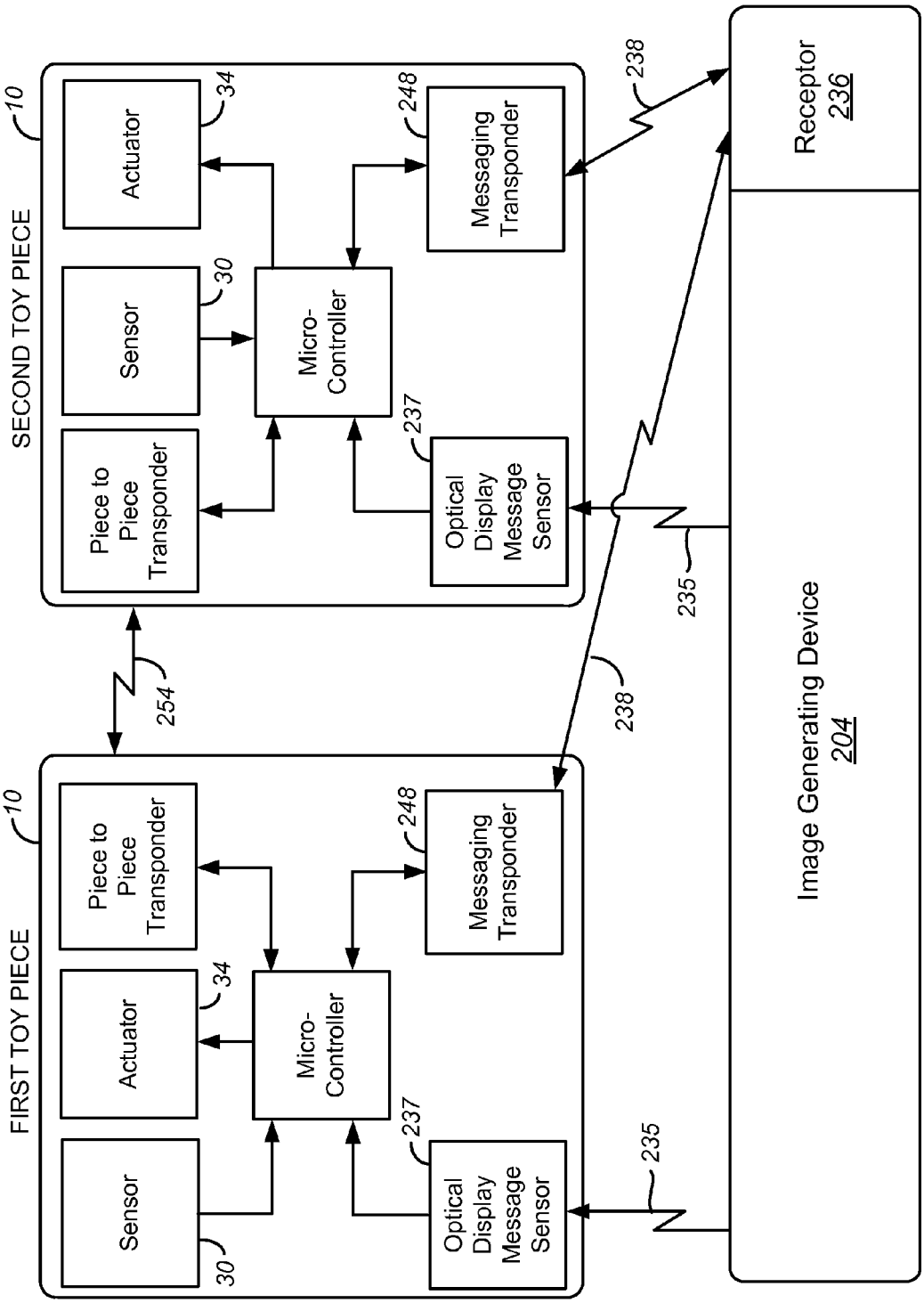
SECOND TOY PIECE
10
Actuator
34
Sensor
30
Micro-Controller
Piece to Piece Transponder
Messaging Transponder
248
Optical Display Message Sensor
237
254
FIRST TOY PIECE
10
Piece to Piece Transponder
Actuator
34
Sensor
30
Micro-Controller
Messaging Transponder
248
Optical Display Message Sensor
237
238
235
Receptor
236
Image Generating Device
204

FIG. 70

BASEPLATE ASSEMBLY FOR USE WITH TOY PIECES

CROSS-REFERENCE TO OTHER APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 13/681,143, filed 19 Nov. 2012, entitled Toy Brick with Sensing, Actuation and Control, which claims the benefit of U.S. provisional patent application No. 61/633,824, filed 17 Feb. 2012.

BACKGROUND OF THE INVENTION

Toy pieces in the form of toy bricks such as LEGO® brand toy bricks have been available for many decades. Toy bricks typically have releasable couplings between bricks, which allow them to be connected to form a larger structure. In their simplest form they build unanimated objects such as castles or houses. In some cases, the toy created using toy bricks can be supported on a baseplate having coupling elements to provide stability or proper positioning, or both, for the toy.

An advancement of toy bricks was the addition of bricks with a rotating joint or axle coupled to a wheel. Such a toy brick can be attached to an inanimate structure in order to make that structure roll along a surface when pushed.

A further advancement of toy bricks was the addition of "pull back motors." These motors are mechanical energy storage elements, which store energy in a watch spring or flywheel. Typically these are toy bricks which have the "pull back motor" mechanism contained within the brick. There is a shaft from the mechanism, which when turned in one direction winds up the motor and then when released will turn in the opposite direction. A toy brick car, for example, equipped with such a motor will wind up when pulled back and then go forwards when released. An example of this is the LEGO Pullback Motor.

The next stage of advancement of a toy brick is an electric motor contained within one brick, having a protruding shaft and another toy brick with a battery compartment. These battery and motor bricks can be coupled to each other directly or through wires in order to create a simple mechanism that is electrically actuated. Typically a switch is present on the brick containing the batteries that can turn the motor on or off or revere its direction. Variations on the actuator can be lights, instead of a motor. An example of this is the LEGO eLab.

Toy bricks containing motors and toy bricks containing batteries can be further enhanced by the insertion of a remote control receiver in between them, such that the passage of power can be modified remotely. Typically a hand held remote control transmitter transmits a signal to a receiver brick, which can change the speed or direction of the motor. By way of example, a toy brick vehicle constructed in such a manner can be steered remotely and also have its speed controlled remotely. An example of this is the LEGO Power Functions.

The most complex state of prior art is the programmable robotics kit sold by the LEGO Group under the trademark Mindstorms®. The kit typically includes a handheld programmable computer, to which sensors and actuators can be plugged in, along with toy bricks and specialized components for making a variety of projects. Actuators can be motors, or solenoids, speakers, or lights. Sensors can be switches, microphones, light sensors or ultrasonic rangefinders. By way of example, a program can be downloaded into the handheld computer, so as to control a motor in a manner so as to avoid collisions with objects in the direction of motion.

Another example would be to make a noise when motion is detected. Another programmable Mindstorms programmable robot is the Micro Scout. It is a motorized wheeled robot in which several preprogrammed sequences can be executed when a light is shined on the robot.

US patent publication US2011/0217898 A1 describes a toy brick with a tilt sensor and lights of the same color turning on and off or flashing alternately in response to a shaking motion. U.S. Pat. No. 7,708,615 discloses a toy brick system having separate sensor bricks, logic bricks and function bricks. The following toy bricks also emit sound when a switch is closed. LEGO doorbell Brick #5771, LEGO Space Sound Brick #55206C05.

Various devices generate images on display screens. One type of image generating device is a computer, such as pad computer, which can be designed to permit interaction with the computer through the display screen. This is commonly through touchscreen technology which permits actions to be initiated by, for example, selecting appropriate icons on the display screen, as well as lines to be drawn on the display screen. In addition to touchscreen technologies, interaction with the computer through the display screen can also be through the use of devices commonly referred to as light pens. See, for example, U.S. Pat. No. 4,677,428. In Light pen based interaction, images are generated on a Cathode Ray Tube (CRT) by excitation of the phosphor on the screen by an electron beam. This excitation causes the emission of light. Since a single point electron beam scans the image in a raster pattern, the light at any one point on the screen fades with time, as the beam progresses to a different part of the screen. During the next scan of the screen the image is refreshed. The intensity at any one point on the screen will flicker at the rate of refresh of the screen, and is typically a sawtooth type waveform with a fast rise and a slower decay if plotted in time. The light from any given point on the screen will increase sharply as the electron beam passes by any location as long as the image is not completely black at that point on the screen. The display knows the position of the electron beam at any given time, and this position can be captured at the instant when a sharp jump in a light level is seen by the light pen. By this method the light pen can be used as a pointing device, typically with additional buttons similar to mouse buttons, which are sometimes arranged so as to be mechanically activated when the pen is pressed against a surface.

BRIEF SUMMARY OF THE INVENTION

A first example of a baseplate assembly, for use with playing pieces configured to allow the playing pieces to be releasably coupled to one another, includes a baseplate and an image generating device operably coupled to the baseplate. The baseplate includes a display region, having coupling elements, by which playing pieces can be releasably mounted to the display region. Display region also includes areas adjacent to the coupling elements. The baseplate assembly also includes means for transmitting images generated by the image generating device at least to the display region of the baseplate.

Some embodiments of the first example of the baseplate assembly can include one or more the following. The image generating device can include a display screen on which images are generated. The images transmitting means can include a generally transparent portion of the baseplate whereby images generated on the display screen can pass through the baseplate to be viewed at the display region of the baseplate. The baseplate can be removably mounted to the image generating device. The image generating device can

include a computer. The baseplate assembly can include a playing piece releasably mounted to a first location on the display region using a coupling element; with the image generating device being a computer, the playing piece and the baseplate can include computer program instructions stored on a non-transit storage medium that, when executed on a processor, cause the processor to perform actions comprising flow or branching dependent upon the messages received from the playing pieces. The baseplate can be constructed so that the images generated by image generating device pass through the baseplate and are visible through the coupling elements and through the areas adjacent to the coupling elements. The assembly can further include a playing piece releasably mounted to a first location on the display region using a coupling element, and a coil for generating a magnetic field for at least one of the following: (1) transferring energy from the baseplate to the playing piece, and (2) transferring a signal to and receiving a signal from the playing piece. The assembly can further include a playing piece releasably mounted to a first location on the display region using a coupling element, the playing piece comprising at least one of a radio frequency identification (RFID) device and a near field communication (NFC) transponder activatable upon receipt of an optical signal by the playing piece. The playing piece can further include a touch sensitive membrane operably coupled to the image generating device, and the baseplate can include a plurality of access regions overlying the touch sensitive membrane to permit a user to provide a touch input to the membrane at at least a selected one of the access regions. The baseplate can include a grid of first and second sets of spaced apart electrodes, the first set of electrodes extending in a direction transverse to the second set of electrodes, with the first and second sets of electrodes operably coupled to the image generating device.

A second example of a baseplate assembly includes a baseplate body, the playing piece and the triangulating means. The baseplate body includes a playing pieces support surface with the playing piece at a position on the playing pieces support surface. The triangulating means being associated with the playing piece and the baseplate body for generating signals indicating the presence of the playing piece at the position on the playing pieces support surface. In some embodiments of the second example, the baseplate body can include coupling elements by which the playing piece can be releasably mounted to the playing pieces support surface.

An example of a baseplate is for use with (1) an image generator having a display screen on which images can be generated, and (2) playing pieces configured to allow the playing pieces to be releasably coupled to one another. The baseplate includes a body and mounting structure. The body includes a display region with comprising coupling elements, by which playing pieces can be releasably mounted to the display region, and regions adjacent to the coupling elements. The body also includes an inner region, the inner and display regions being on opposite sides of the baseplate. The mounting structure by can be used to removably mount the body to an image generator so that the inner region of the body is positioned adjacent to the display screen of the image generator. At least a portion of the body between the inner region and the display region can be generally transparent so that images generated at the display screen of the image generator can pass through the body to the display region and be visible at the coupling elements and at the regions adjacent to the coupling elements.

An example of an image generating and playing-piece-interacting assembly, for use with playing pieces, includes an image generating device, a receptor operably coupled to the image generating device, and a first playing piece. The image generating device has a display screen on which generated images can be displayed. The generated images include integrated visual and optically encoded message images. The first playing piece can be at a first location relative to the display screen. The first playing piece includes an optical display message sensor and a messaging transponder. The optical display message sensor is configured to receive the integrated visual and optically encoded message image and to generate a first signal at least partially based upon the optically encoded message image. The messaging transponder is coupled to the optical display message sensor for receipt of at least the first signal from the optical display message sensor. The messaging transponder is also coupled to the receptor for generating and sending to the receptor a second signal at least partially based upon the first signal.

Some embodiments of an image generating and playing-piece-interacting assembly can include one or more the following. The receptor can be at least one of a sound receptor, an electromagnetic radiation receptor, and a magnetic field receptor, and the second signal can include a corresponding one of a sound second signal, an electromagnetic radiation field second signal, and a magnetic field second signal. The assembly can include a baseplate mountable on the display screen, the baseplate including a display region, the display region including coupling elements by which playing pieces can be releasably mounted to the display region. The optically encoded message image can be visually imperceptible to a user. The optically encoded message image can contain information encoded as being addressed to a specific playing piece. The second signal can include one or more of the following (1) graphic representation for the first playing piece, (2) other information for the first playing piece, and (3) an address into at least one of a local database, a remote database, a look-up table; which contains information for the first playing piece. The optically encoded message image can change according to the physical position of the optically encoded message image on the display screen. The optically encoded message image can contain information regarding at least one of (1) coordinates for the physical position, and (2) information regarding the visual image portion of the generated image at the physical position, (3) gaming data for the playing piece, (4) data for an actuator on the playing piece. The optically encoded message image can be generated at a number of physical positions on the display screen, and a second playing piece can be at a second location relative to the display screen. The assembly can also include first and second operably coupled image generating devices, a second playing piece at a second location relative to the display screen of the second image generating device, and an optically encoded message image to the second playing piece can be at least partially based upon the second signal from the playing piece. A second playing piece can be at a second location relative to the display screen, the optically encoded message image to the second playing piece can be at least partially based upon the second signal from the first playing piece. The each of first playing piece and the second playing piece each can include a playing-piece-to-playing-piece communication device to permit transfer of messages therebetween. The first playing piece can include a sensor coupled to the messaging transponder to provide sensor data to the messaging transponder, so that the second signal can be generated at least in part based on the sensor data. The first playing piece can include at least one of (1) an actuator operably coupled to receive a message from the optical display message sensor, and (2) an actuator operably coupled to receive a message

from the messaging transponder, the message comprising data for actuation of the actuator.

Other features, aspects and advantages of the present invention can be seen on review the drawings, the detailed description, and the claims which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1-35**, described below, are taken from U.S. patent application Ser. No. 13/681,143.

FIG. **1** shows an example of a toy brick including a solar cell and an actuator shaft.

FIG. **2** is a block diagram of internal components of a toy brick.

FIG. **3** is an example of a toy brick including an induction charging device.

FIG. **4** is an example of a toy brick including a microphone or a light detector.

FIG. **5** is an example of a toy brick including an RF receiver or a GPS sensor.

FIG. **6** is an example of a toy brick including a 3-D tilt, or gyroscope, or gravity sensor.

FIG. **7** is an example of a toy brick including a camera.

FIG. **8** is an example of a toy brick including one or both of a shaft angle sensor and a shaft extension sensor.

FIG. **9** is an example of a gripper force toy brick including a gripping force sensor including a strain gauge rosette.

FIG. **10** illustrates, in a simplified manner, components within the gripper force brick of FIG. **9**.

FIG. **11** is example of a toy brick including electrical switches at an outside surface.

FIG. **12** is a simplified view showing how the electrical switches of the toy brick of FIG. **11** are connected to the computing control element of the toy block.

FIG. **13** is an example of a toy brick including a temperature transducer.

FIG. **14** is a simplified view illustrating how the temperature transducer of FIG. **13** is coupled to the computing control element of the toy brick through an amplifier.

FIG. **15** is a block diagram of an example of a microcontroller for use with a toy brick.

FIG. **16** is a flow diagram illustrating power management signal detection and actuation.

FIG. **17** is an example of a toy brick including a light source.

FIG. **18** is an example of a toy brick including a speaker.

FIG. **19** is an example of a toy brick including a flat display.

FIG. **20** is an example of a toy brick including at least one of an organic LED and an organic LCD.

FIG. **21** is an example of a toy brick including a projected image from a projected image display.

FIG. **22** is an example of a toy brick including an image from a fiber optic display.

FIG. **23** is an example of a toy airplane built with toy bricks, which can emit sound or turn a propeller when moved as detected by a motion sensor.

FIG. **24** is an example of a toy car with a toy brick including a motion sensor, a recorder, and a speaker for emission of car sounds.

FIG. **25** is an example of a toy train built with toy bricks, including a camera brick as in FIG. **7** for display of an image from the camera on a mobile or fixed computing device.

FIGS. **26-28** illustrate examples of toy bricks shaped as flying insects or aircraft and displaying images reminiscent of different insects or aircraft.

FIG. **29** illustrates a mobile computing device used to update the image on the flying insect or aircraft toy bricks of FIGS. **26-28**.

FIG. **30** is a simplified block diagram illustrating an example of a toy brick solar panel recharging system.

FIG. **31** is a simplified block diagram illustrating an example of a toy brick inductively coupled recharging system including an inductive charging device.

FIG. **32** is a flow diagram illustrating an example of a crash test recording algorithm.

FIG. **33** is a flow diagram illustrating an example of an addressable device communication algorithm.

FIG. **34** is a flow diagram illustrating a color change brick algorithm.

FIG. **35** is an algorithm for manipulation of toy brick avatars.

FIG. **36** is an overall view of a baseplate assembly with a portion of the baseplate removed to disclose the display region of the image generating device.

FIG. **37** shows a first example where the image is generated remotely for transmission to baseplate **202** using a DLP projection system.

FIG. **38** shows a second example where the image is generated remotely using a mirror to direct the image from the display screen onto the baseplate.

FIGS. **39** and **40** illustrate two examples for transmitting the image to the upper surface of the baseplate using optical fibers.

FIGS. **41-43** top plan views of a baseplate assembly in which the baseplate includes a first portion offset from and surrounding the display screen.

FIG. **42** shows the structure of FIG. **41** with a second portion of the baseplate positioned within the interior of the first portion and providing an open region permit direct visual access to a portion of the display screen.

FIG. **43** shows the structure of FIG. **41** with an alternative second portion of the baseplate occupying the entire interior of the first portion of the baseplate thereby completely covering the display screen.

FIG. **44** is a simplified partial cross-sectional view of an example of the baseplate assembly of FIG. **36** in which the image generating device includes a touch sensitive membrane situated directly above the display screen, portions of the baseplate that surround the coupling elements being flexible elements permitting the coupling elements to be deflected by a user from the spaced apart position shown in FIG. **44** to a position contacting the touch sensitive membrane.

FIGS. **45** and **46** show alternative examples of the structure of FIG. **44** in which the flexible elements are zigzag thin flexible elements in FIG. **45** and are spaced apart elements created by cutouts in the baseplate in the example of FIG. **46**.

FIG. **47** is a further alternative example of the structure of FIG. **44** in which the access regions are created by holes formed in the baseplate at positions offset from the coupling elements.

FIG. **48** is a simplified partial top view of a baseplate including a grid of first and second sets of spaced apart, parallel electrodes oriented transversely to one another used to determine where on the baseplate the user is touching the baseplate directly or through a toy brick.

FIG. **49** is a simplified cross-sectional view illustrating an example of a baseplate including capacitive touch electrodes.

FIG. **50** is a simplified top view of a portion of the baseplate assembly of FIG. **36** showing an image projected onto the display region of the baseplate. Based upon the location of a toy brick on the baseplate, information, such as a message or signal, can be provided the toy brick by the image.

FIG. **51** is a view similar to that of FIG. **50** but in which a portion of the image is dimmed to convey information to the toy brick as an optical encoded message image.

FIG. **52** is a top plan view of a baseplate assembly including a receptor which can receive a signal from a toy brick mounted to the display region of the baseplate, the signal can be generated in response to the optical encoded message image projected onto the display region of the baseplate. The signal generated by the toy brick can include information such as the location of the toy brick and the type of toy brick.

FIG. **53** illustrate an example in which a portion of the image, that is the optical encoded message image, is in the form of a two dimensional barcode which can be scanned or imaged by the toy brick placed on the display region of the baseplate.

FIG. **54** is a flow diagram of an example of software implementation of a scanning routine.

FIG. **55** is a schematic representation of the components of an example of a baseplate assembly and a toy brick or other playing piece, and interactions between and among the components.

FIG. **56** is a schematic representation of the manner in which a memory mapped, time varying, communication image and memory mapped, time varying, gaming image are combined to create the memory mapped, time varying, displayed image.

FIG. **57** is a schematic representation of the manner in which a memory mapped, time varying, message data is modified by a memory mapped time varying, modulation function in order to obtain memory mapped, time varying, communication data.

FIG. **58** shows an example of an implementation including a baseplate assembly and a near field communication (NFC) reader and the use of RFID tags.

FIG. **59** is a block diagram showing interaction between the baseplate and a toy brick or other playing piece where and RFID tags are used, such as in the example of FIG. **58**.

FIG. **60** is a simplified view of an example of a baseplate assembly in which the toy brick or other playing piece has more than one optical receptor.

FIG. **61** is a schematic representation of a baseplate including column scan lines extending in one direction and row scan lines extending in a transverse direction, the scan lines bounding the coupling elements. Electrical coils are connected to the row and column scan lines at their intersections for communication with toy bricks, typically positioned directly above the coils.

FIG. **62** shows structure similar to that of FIG. **61** but having a light emitting device, such as an LED, at each intersecting row and column line and adjacent to coupling elements.

FIG. **63** shows a baseplate assembly including triangulating transmitters/receptors at the four corners of the baseplate to permit the position of the toy brick on the baseplate to be determined.

FIGS. **64-67** show different modes of communication by the toy brick or other playing piece.

FIG. **68** is a simplified schematic diagram showing a baseplate and triangulating transmitters/receptors at the corners.

FIG. **69** is a simplified side cross-sectional view of a toy brick with a combination of straight, parallel optical fibers and curved optical fibers two direct the image to more than one surface of the toy brick.

FIG. **70** is somewhat similar to that of FIG. **55** but showing the interaction among two playing pieces and one image generating device, the image generating device including a receptor as shown in FIG. **52**.

DETAILED DESCRIPTION OF THE INVENTION

The following description will typically be with reference to specific structural embodiments and methods. It is to be understood that there is no intention to limit the invention to the specifically disclosed embodiments and methods but that the invention may be practiced using other features, elements, methods and embodiments. Preferred embodiments are described to illustrate the present invention, not to limit its scope, which is defined by the claims. Those of ordinary skill in the art will recognize a variety of equivalent variations on the description that follows. Like elements in various embodiments are commonly referred to with like reference numerals.

The prior art discussed above consists of inanimate toy bricks suitable for small children, or more complex powered and wired or coupled toy brick elements, which must be assembled intelligently, in order to perform a function. The toy bricks which require intelligent coupling in order to perform a function are suitable for much older children. Examples of the toy brick described herein allow some animation functions to be experienced by younger children, without requiring them to understand electrical concepts. The toy bricks, as well as other playing pieces, are also well-suited for use with baseplate assemblies discussed below starting with FIG. **36**.

In addition, the prior art discussed above typically requires wiring between blocks to provide power to and control functions between the blocks. Such wires or connection between blocks distract from the object to be created by the blocks. Examples of the toy brick will also allow some functions to be achieved without the use of wires. While the toy brick building system disclosed in U.S. Pat. No. 7,708,615 does not require wires, it discloses the use of function bricks, sensor bricks and logic bricks which require intelligent assembly and thus may not be suitable for younger children.

An intent of the various examples of the toy brick is to provide the end user with a rich experience from a toy brick, without burdening the user with needing to gain knowledge of how that experience is delivered. Typically a user would perform an action in order to initiate the experience, sensors and a controller within the toy brick would detect the interaction of the user with the brick, the toy brick will then automatically perform an action, in response to the stimulus.

As shown in FIG. **1**, a first example of a toy brick is a single toy brick **10** including a housing **12** typically of size 3 inches or less on each side, the housing carrying coupling elements **14** used to releasably couple housing **12** of one toy brick **10** to the housing of another toy brick. The coupling element typically include pegs or other extending elements acting as first coupling elements which mate with corresponding openings, not shown, formed on housing **12** of other toy bricks **10**. For ease of illustration only one set of peg-type coupling elements **14** are shown. Coupling elements **14** are typically conventional and may be compatible with coupling elements used with LEGO® brand toy bricks. The toy brick **10** example of FIG. **1** also includes a solar cell **16** mounted to one side of housing **12** and a shaft **18** extending from another side of housing **12**. Solar cell **16** forms part of the power source for a toy brick **10** while shaft **18** is a type of actuator. These features will be discussed in more detail below. A toy brick **10** will also include sensing and control functions integrated within the toy brick.

Such a toy brick **10** would perform a function in response to a stimulus. The function to be performed is dependent on the sensors present, the programming of the controller, and the actuators present on toy brick **10**, which are discussed in detail below.

FIG. **2** is a block diagram **20** of the main functional components of an example of toy brick **10**. In this example, the charging device **22**, which typically is in the form of solar cell **16** or an inductive charging device **24** shown in FIG. **3**, is mounted to or is an integral part of housing **12**. Solar cell **16** can be used to create electricity from light. Inductive charging device **24** uses electromagnetic induction to create electrical current to charge energy storage element **26**. An external charging station, not shown, creates an alternate magnetic field and is positioned near the coils of inductive charging device **24** to send electromagnetic energy to inductive charging device **24** thereby inducing an electrical current within the coils of inductive charging device **24**. Charging device **22** is connected to a rechargeable electrical energy storage element **26** by a line **28**. Energy storage element **26** is typically in the form of a battery. However, energy storage element **26** can also be of other types, such as a capacitive energy storage element. Charging device **22** and energy storage element **26** constitute a power source **29**. Energy storage element **26** is connected by power lines **36** to at least one sensing element **30**, a computing control element **32**, and usually to at least one actuator **34**. Sensing element **30** communicates with computing control element **32** through a line **38** while computing control element **32** is coupled to actuator **34** by a line **39**. In some cases, any power required by actuator **34** may be provided through, for example, computing control element **32**.

The provision of a rechargeable power source **29** within the toy brick **10** will allow the toy brick **10** to be incorporated into structures without the need for wires. Further, recharging capability will allow any model or other structure built with the toy brick **10** to exist without requiring disassembly for replacing or recharging the batteries. The ability to transfer electrical power without electrical contact will also allow the brick to be hermetically sealed, so as to be child friendly.

A function of some examples of the toy brick is to detect an input via the sensing element **30**, then determine via computation or other logic as described below if the input conditions satisfy the predetermined requirements to actuate one or more actuators **34**, and if so actuate one or more actuators **34**, typically in sequence or simultaneously as per a predetermined pattern.

Sensing elements **30** can be one or more of the following: (1) a microphone **40** for reception of a sound encoded trigger, such as, but not limited to a clapping sound or voice recognition as shown in FIG. **4**; (2) an infrared or visible light detector **42** for receiving a light encoded trigger as shown in FIG. **4**, such as but not limited to a signal from an infrared remote, or the passage of a flashlight beam across a light sensor; (3) an RF transceiver **44** for detecting a radio frequency encoded trigger as shown in FIG. **5**, such as but not limited to a Bluetooth signal from an iPad; (4) a 3 dimensional tilt sensor, or gyroscopic sensor, or gravity sensor **46**, as shown in FIG. **6** for detecting a motion triggered event such as but not limited to, a shaking of the toy brick **10** or orientation of the toy brick, or a time course of certain motions of the toy brick; (5) a camera **48** for capturing still or moving images, as shown in FIG. **7**; (6) a position triangulation sensor **50** such as but not limited to a global positioning sensor as shown in FIG. **5**; (7) a shaft angle sensor **52**, as shown in FIG. **8**; and (8) a shaft extension sensor **54** also shown in FIG. **8**.

A gripping force sensor **56**, typically in the form of a strain gauge rosette as shown in FIG. **9**, can be used to sense forces exerted on toy brick **10**. FIG. **10** illustrates, in a simplified manner, components within a toy brick **10**, sometimes referred to as a gripper force brick **10**, including an amplifier **58** coupled to computing control element **32**. For example, two push button electrical switches **60**. Although switches **60** are shown both on one side of toy brick **10**, a greater or lesser number can be used and can be on more than one side. FIG. **12** illustrates, in a simplified form, switches **60** coupled to computing control element **32** within toy brick **10**

In some examples, not illustrated, toy brick **10** may be constructed so that it takes more force to decouple a component, such as power source **29**, actuator **34** or sensing element **30**, from housing **12** than it does to decouple the housing **12** of one toy brick **10** from the housing **12** of another toy brick **10**.

FIG. **13** shows a temperature transducer type of toy brick **10** which includes a temperature transducer **62** typically secured along the inside surface of one of the walls of the toy brick. Temperature transducer **62** may be of different types including resistive, thermocouple, and semiconductor temperature transducers. FIG. **14** shows temperature transducer **62** coupled to computing control element **32** through an amplifier **64**. Computing control element **32** can be implemented by, but is not limited to, a microprocessor, or analog or digital circuit, or fuzzy logic controller. FIG. **15** is a schematic diagram illustrating one example of a computing control element **32** in the form of a microprocessor. The programming of computing control element **32** can be preset at the factory, or may be programmable or reprogrammable in the field.

Computing control element **32**, in the example of FIG. **15**, is a single chip microcontroller. A microcontroller is a microprocessor with several different peripherals such as memory, communication devices, input and output devices built into a one-piece silicon die.

Peripherals can include but are not limited to: USB (Universal Serial Bus), USART (universal synchronous/asynchronous receiver transmitter), I2C (I-squared-C) computer bus, ADC (Analog to Digital Converter), DAC (Digital to Analog Converter), Timers, Pulse Width Modulators, Flash Memory, RAM Memory, EEPROM (Electrically Erasable Programmable Read Only Memory), Bluetooth interface, Ethernet interface, liquid crystal driver interface. An example of such microcontrollers would be the Texas Instruments TMS320LF28XX family or MSP430 family of microcontrollers.

Typically a microcontroller is designed to perform a specific task, and only requires a subset of all possible peripherals to be present in order to perform that task. Usually only the input and output of the peripheral devices are externally accessible via metal pins. The internal data and memory access bus structure is not typically connected to the externally accessible pins of the chip.

The microcontroller receives signals as electrical voltages or currents, presented to one or more of its externally accessible pins. These signals are typically sampled on a one time basis, continuously, or at a regular time intervals by circuitry within the microcontroller, such as an analog to digital converter. The time course and amplitude of such a signal may be kept in the internal memory and analyzed by algorithms. By way of example, a speech recognition algorithm may analyze digitized speech from a microphone, or a motion detection algorithm may analyze signals from accelerometers or tilt switches.

The algorithms which analyze the digitized electrical signals, can be written in a language such as Basic, C or Assembly. The Algorithms may implement logical functions such as: "IF INPUT signal is GREATER THAN a VALUE THEN turn ON an OUTPUT". The signals may in addition be transformed by transforms such as but not limited to the Fourier transform, or form feedback based algorithms in the S or Z domain such as Kalman Filters. Other algorithms such as neural network based fuzzy logic are also implementable.

Indeed almost any algorithm that can be run on a personal computer can be implemented on a microcontroller based design.

Signals received may also be from a communication device, such as a Bluetooth link to an external device such as an iPad® or other tablet computer. Such signals may contain a full message of actions to perform, requiring the microcontroller to perform those actions rather than attempt to make a decision as to if actuation is warranted.

Computing control element **32**, in the form of microcontroller **32**, receives electrical signals, performs analysis of said signals and then performs an action. Signals for actuation are sent as electrical signals from the pins of microcontroller **32**. By way of example, actuation such as making a noise may require microcontroller **32** to create a time course of electrical signal amplitudes, which may be accomplished by means of a DAC (Digital to Analog Converter) which varies the amplitude of the voltage on a pin of microcontroller **32**. In another embodiment, actuation of a display, for example, may require microcontroller **32** to send out RGB (Red/Green/Blue) intensities to various display pixels in order to create an image.

Microcontroller **32** may in addition manage battery charging and also conservation of power by powering down peripherals, and even entering a low power mode (sleep mode) and only exit from the low power mode (wake up) at either certain intervals to check if signals are present, or may wake up due to a signal being presented to one or more peripherals which are capable of waking the microcontroller from a sleep state.

Computing control element **32** analyzes the signals from the one or more sensing elements **30**, as described below by way of example in FIG. **16**, and makes a determination as to if actuation is warranted, and then sends signals to one or more actuators **34** as prescribed by the logic or programming of the computing control element **32**. The computing control element **32** will also typically have memory that is readable and writeable, and may be nonvolatile. The programming of computing control element **32** may, in some examples, be altered in the field by erasing and rewriting the program memory via wireless download, for example. Data form signals monitored may also be stored in the memory for later retrieval. For example, a toy brick **10** that is involved in a crash test may have its motion during the crash stored inside the memory of the computing control element **32** of the toy brick for later retrieval and display, or a video or picture may be stored on the toy brick for later retrieval and display.

An example of a process for power management, signal detection and actuation is shown in FIG. **16**. Initially, after start step **65**, computing control element **32** is in a powered down mode as indicated at step **66**. At step **68**, if there is no signal from a sensing element **30**, the program returns to step **66**. If there is a signal from a sensing element **30**, the program resets power on the timer at step **70** to a fixed predetermined number, such as 60 seconds. After step **70**, there is an inquiry at step **72** whether or not there is a signal. If there is a signal, such as from an accelerometer, an appropriate actuation, such as emission of a sound, is conducted if conditions for the actuation are satisfied at step **74**, followed by return to step **70**. If there is no signal, control passes to step **76** and the power on the timer is reduced. Control then passes to step **78** where the inquiry of whether power on the timer has expired is made. If yes, control is returned to step **66**. If no, control is returned to step **72**.

Actuators which generate the output of a toy brick **10** can be, but are not limited to, one or more light sources **80**, as shown in FIG. **17** and sound emission devices, such as speaker **82** as shown in FIG. **18**. In addition, output can be generated by graphical displays including flat displays **84** as shown in FIG. **19**, organic LED or organic LCD wraparound displays **86** as shown in FIG. **20**, projected image displays **88** and the associated projected image **90** as shown in FIG. **21**, and fiber-optic displays **92** and the associate projected image **94**. In addition, output can be generated by a variety of other devices such as motors, radio transmitters, radio transceivers and solenoids. Actuators **34** can also include various types of transmitters. Actuation can be simple on/off or more complex actions such as but not limited to transmission of a radio signal, or even a time course of actions.

Examples of Various Embodiments of Toy Bricks:

By way of example, in one embodiment, a single brick **10**, similar to that shown in FIG. **1**, may, when left undisturbed simply go to a "sleep" state, such as when power on the timer has expired at step **78** in FIG. **16**, while charging its battery or other energy storage element via ambient light, from a solar cell **16** on one of its surfaces. Then when brick **10** is lifted, it may, for example, emit the sound of an airplane taking off, when dived make the sound of an airplane diving, and when shaken emit the sound of guns. Such a brick **10** would be suited to the building of a toy brick fighter aircraft as shown in FIG. **23**. The toy brick fighter aircraft as shown in FIG. **23** is constructed with a single toy brick **10** including the components illustrated in FIG. **2**. The other toy bricks used in the construction of the toy brick fighter aircraft are conventional toy bricks without the components of FIG. **2**. However, as discussed below, additional toy bricks **10** could be used in the construction of the toy airplane.

In yet another embodiment, a single brick with integral solar power battery and Bluetooth receiver, again see FIG. **1**, may spin a small motor with a shaft protruding from one side, when a Bluetooth radio signal is received from, for example, a tablet computer, such as an iPad®, or a smart phone, such as an iPhone®. Such a brick may be used in a windmill, for example. Another use of such a brick may be to build several small toy brick airplanes **96**, as shown in FIG. **23**, which can be remotely made to turn their propellers **98** when a Bluetooth signal is sent from a mobile or fixed computing or communication device.

In yet another embodiment, shown used as a component of a racecar **100** in FIG. **24**, a brick **10** may incorporate several features, such as speaker **82** of the brick **10** of FIG. **18**, and 3-D movement sensor **46** of the brick **10** of FIG. **6**, and make an engine revving sound when moved back and forth and the sound of a car "peeling tires" when pushed fast in one direction.

In yet another embodiment, a clear brick **10**, similar to that of FIG. **17**, with a self-contained power source may have red, green, and blue light sources **80** within it and have its color set by remote from an iPad per the computer algorithm described below with reference to FIG. **34** or, in another embodiment, change color when held at different orientations by means of actuation being controlled by a tilt or gravity sensor.

In yet another embodiment as Shown in FIG. **25**, a toy brick **10** with a camera **48** similar to that shown in FIG. **7**, may transmit a video signal via Bluetooth or Wi-Fi to a mobile or fixed device including a display screen. Such a brick when incorporated into a model such as, but not limited to, a toy brick train **102**, will enable a view **104** as seen from the toy to be experienced by the user on, for example, a tablet computer screen.

In yet another embodiment, not illustrated, a toy brick **10** with a camera **48** and integral face or object recognition algorithm may greet a child with a sound such as "Hello John" when approached. The face to be recognized and the sound to be emitted by the brick may be user downloadable into the toy brick **10** via radio link. The face may even be self-learned by

the video captured by the camera itself. Alternatively when the face is recognized the toy brick may transmit a signal to a fixed or mobile computing device.

In yet another embodiment, a sequence of sensing and a sequence of actuation may be programmed, typically by an adult, into the toy brick **10**, with perhaps the aid of a user interface running on a fixed or mobile computing device, with radio link or other connection to the toy brick. Once programmed, a child may interact with the brick in a much simpler manner.

In yet another embodiment, several different shaped bricks may be manipulated by a child or other user. The bricks will transmit their shape and position to a fixed or mobile computing device which will show the manipulation of the bricks, with correct shape and size in a virtual building environment on a display screen. Transmission of position may be done by GPS signal, or by a more localized triangulation method, such as through the use of a baseplate, on which the toy bricks **10** are supported, with triangulation capability. The following are three examples of methods of position triangulation.

Measurement of time delay of signals from a signal source of known position: One or more signal sources of known position may send a pulse ("ping") or encoded message via sound, light or radio wave, at a certain time. The message may contain the time that this signal was sent. The message will be received at a later time by the object that is to be triangulated, in this case typically a toy brick **10**. By receiving messages from 3 or more such sources of known positions, and by computing the distance to those sources by measuring the delay between the time that the signal was sent and the time that the signal was received, it is possible to triangulate by standard trigonometric methods the position of the object to be triangulated. A simplified embodiment of a toy brick baseplate can be constructed to be capable of triangulating an object, such as toy brick **10**, placed upon it. Such a triangulating baseplate may contain four or more signal emitters at the corners, in the plane of the baseplate and also above the plane of the baseplate. These emitters will emit encoded signals, preferably simultaneously. Then by measurement of the time delay between reception of the signals, it would be possible to locate the three-dimensional position of a toy brick in the vicinity of the baseplate.

Measurement of the position of known landmarks, by image analysis: The object to be triangulated may contain a camera and may compute its position by measurement of angles to various landmarks present in the image. By way of example, a toy brick **10** may contain a camera **48** and analyze the position of, for example, specific colored or marked bricks or flashing lights, placed in and above the plane of a base plate.

Measurement of the position of an object by analysis of its position relative to a known landscape: An object may be photographed in two or more, preferably orthogonal, views against a known landscape and its position computed. By way of example, a toy brick baseplate assembly may be constructed to contain two or more cameras capable of photographing the object in plan and elevation, against the baseplate and/or an orthogonal vertical wall with features present upon the baseplate/wall, such as uniquely marked bricks or flashing lights, whose positions are known.

The bricks may be cemented into position in the virtual environment by a gesture of the brick (such as but not limited to a clicking motion) or by pushing a button on the brick as described in the computer algorithm described below with reference to FIG. **35**. What is referred to as a clicking motion may be carried out by hovering over a correct position followed by a sharp downward thrust reminiscent of a mouse click. Such manipulation will allow the same brick to be used repeatedly to create a structure in the virtual environment, while no physical structure is created. Further, the manipulated brick may have its avatar on the virtual screen changed so as to be a different shape than the physically manipulated brick; in this case, the physically manipulated brick may be of arbitrary shape.

In yet another embodiment, a toy brick with an accelerometer may be placed in a brick constructed car, such as that shown in FIG. **24**, and the acceleration, velocity and position of the car, transmitted and plotted on a mobile or fixed computing device. This will allow standard physics experiments such as acceleration down an inclined plane to be generated with ease. In addition, g forces during a crash test can be plotted and examined. It should be noted that the data may be stored on the brick itself for later retrieval, rather than transmitted in real time.

In yet another embodiment, bricks may be grouped by electronic addressing scheme, as described below with reference to in FIG. **33**, such that they may respond individually or as a group to a stimulus. By way of example, four identical toy bricks capable of changing color when shaken, two may be programmed to become red and two may be programmed to turn green. In yet another example of addressing and grouping, bricks with the actuator being a motor may be grouped by electronic addressing scheme. Such bricks may be incorporated in two grouped squadrons of toy brick airplanes, and one or the other squadron selectively commanded to spin their propellers upon command from a fixed or mobile computing device via wireless command. It can be seen by a person skilled in the art that electronic addressing will allow an entire landscape of toy bricks **10** to be commanded via radio or other signal individually, grouped or in a time sequenced manner.

In another embodiment, such as shown in FIG. **19**, one or more LCD or other type of color or monochrome displays may be embedded within the brick and multiple images from multiple displays, or multiple images from a single display may be transmitted to one or more surfaces of the toy brick via optical elements such as but not limited to prisms, lenses, as shown in FIG. **21**, or by means of light guides such as optical fibers **101** as shown in FIG. **22**. By way of example, a toy brick **10** shaped as a flying insect as shown in FIGS. **26-28** may be set to display, for example, the image of a bee **105** as in FIG. **26**, or display the image of a locust **106** as in FIG. **27**, or an altogether different image **107** as in FIG. **28**. The toy brick **10** may be opaque with only some areas having a display, or fiber optic. Brick **10** may have its image updated via integral wireless connection to a fixed or mobile computing device **109** as shown in FIG. **29**. The display device can also be of a thin film wrap around type, such as an organic LCD or organic LED displays **86** as shown in FIG. **20**. Such a display device can form the "skin" of the toy brick rather than a traditional flat screen device.

FIG. **30** is a block diagram illustrating an example of a toy brick solar panel recharging system **108**. System **108** includes a solar cell **16**, or other photovoltaic source of electricity, which provide energy to energy storage element **26**, typically in the form of a battery or capacitor plus associated charging circuitry. Energy storage element **26** is then used to provide power to various systems **110**, such as sensing element **30**, computing control element **32** and actuators **34** of FIG. **2**.

FIG. **31** is a simplified block diagram illustrating an example of a toy brick inductively coupled recharging system **112** including an inductive charging device **24**, typically in the form of an electrical coil, which supplies electrical energy to energy storage element **26**, typically in the form of a battery or capacitor plus associated charging circuitry. As with the

example of FIG. **28**, energy storage element is then used to provide power to various systems **110**.

FIG. **32** is a flow diagram illustrating an example of a crash test recording algorithm **114**. After start at step **116**, acceleration in all three axes is checked at step **118**. If acceleration is not greater than a threshold along any of the X, Y or Z axes as determined at step **120**, control is returned to step **118**; otherwise control is transferred to step **122**. At step **122** one or more of acceleration, velocity and position data is recorded and/or transmitted until acceleration is below a threshold value or until a threshold time period has elapsed. Thereafter control is passed to step **124** at which one or more of acceleration, velocity and position data is transmitted to computing control element **32**. After that the algorithm terminates at step **126**.

FIG. **33** is a flow diagram illustrating an example of an addressable device communication algorithm **128**. After start step **130**, broadcast data is received from a fixed or mobile computing device at step **132**. Thereafter, at step **134**, an inquiry is made whether or not the broadcast address matches a device address or an address in an address bank. If no, control returns to step **132**. If yes, control passes to step **136**. At that step the broadcast data is acted upon to, in this example, actuate a device or display an image as prescribed. By way of example, assume use of binary 8 Bit addressing with a possibility of 256 uniquely addressable light emitting toy bricks **10**, such as that shown in FIG. **17**. The toy bricks **10** may be assigned arbitrarily to banks, such that bricks 1, 56 and 233 will be in bank "A" and bricks 2, 45 and 123 are in bank "B". A signal may be sent to all bricks in bank "A" to turn on and display red, and all bricks in bank "B" to turn on and emit green light. Thereafter control passes to stop step **138**.

FIG. **34** is a flow diagram illustrating a color change brick algorithm **140**. After start step **142**, either three-dimensional brick tilt data is obtained from a 3 dimensional tilt sensor **46** or information on the color to be displayed is received from a mobile or fixed computing device via an RF transceiver **44** at step **144**. Next, at step **146**, the color to be displayed based on the data received from the sensor is computed. At step **148** the color is displayed on the toy brick **10** by adjusting red, green and blue intensities as needed. Thereafter control is passed to the stop step **150**.

The final algorithm to be discussed is the algorithm for avatar manipulation **152** shown in the flow diagram of FIG. **35**. This algorithm is run on the fixed or mobile computing device, not illustrated, receiving data from the brick being manipulated. After start step **154** data is received from a manipulated toy brick at step **156**, by way of example, from sensors such as orientation sensor **46** and position sensor **50**, and communicated via transceiver **44**. Next, at step **158**, the position and orientation of toy brick **10** is computed. Next, the avatar of the toy brick **10** is displayed on a display screen, such as found on a smart phone, a fixed computer or a tablet computer, at step **160**. Following that, at step **162** the program checks to see if toy brick **10** has moved in a clicking motion, signifying the toy brick is to be cemented in that position, or some other signal signifying that the toy brick is to be cemented in position is received. If no, control is returned to step **156**. If yes, control passes to step **164** at which the brick avatar is cemented in position on the screen, followed by return of control to step **156**.

In some examples, computing control element **32** is a user reprogrammable computer control element in contrast with a computer control element that cannot be reprogrammed during normal use, but typically only in a manufacturing-type environment. Such reprogramming can take place in the manners discussed above with regard to the communication algorithm of FIG. **33**, the color change algorithm of FIG. **34**, and the avatar manipulation algorithm of FIG. **35**. That is, the reprogramming of computer control element **32** can be accomplished by either specifically reprogramming the software or as a function of how the toy brick **10** is used.

In some examples, toy brick **10** can generate an output based upon a currently sensed input value and a previously sensed input value. This is opposed to a decision based on a current input only, such as single push of a button. This aspect is based in part on things that happened prior to an event, e.g., two buttons pushed one second apart. In digital computing terms current and previous means more than one clock apart, which in the current generation of computers running at say 4 GHz is 1/(4×10^9)=0.25 nanoseconds. A computer's ability to define NOW and BEFORE is defined by its clock speed, since it can only sense things once per clock cycle. However it is possible to have an analog computer do a continuous time integral, for example, the time integral of acceleration yields velocity, and you could have a trigger that triggers when the velocity, as computed by a continuous integral of acceleration, exceeds a certain velocity. In another example, toy brick **10** may be provided an input in the form of a signal received by RF transceiver **44** telling toy brick to await further instruction in the form of an oral command received by microphone **40**.

In some examples, toy brick **10** can generate an output(s) or time course of output(s) based on a time course an input(s), wherein the current output(s) or time course of output(s), is determined by mathematical computations based on previous input(s) as well as the current input(s). An example of this is a force or acceleration sensor(s) the signals from which can be integrated to find velocity and integrated again to compute position. Integration is the area under the curve, which is a function of the past history of the signal amplitude over time. In other examples, the mathematical function described can be altered in the field via wired or wireless download of new algorithms. An example of this is a brick which can emit green light when shaken, or can be, for example, reprogrammed via Bluetooth connection to emit red light when shaken. In a further example, each input has more than two possible states (with on and off being two states). Instead, each input may have a continuum of gradually changing values, such as would exist with the input from an accelerometer, the brick may be programmed to continuously change through all the colors of the rainbow as it is tilted in various orientations.

In other examples, toy brick **10** can perform one way or two way communication with an external device wirelessly. The messaging between the devices being more complicated than the detection and/or generation of an instantaneous presence or absence of signal, and is a decoding of the time course of such a signal, said time course carrying an embedded message. An example of this type of toy brick is one which responds to the complex on/off time course of pulsations of light carrying a message from, for example, an infrared remote control.

It can be seen to a person skilled in the art that such a self-contained brick with power, sensing, actuation and control elements within it, sacrifices little of the complex functions possible with the multi-brick prior art. Instead it allows a simple user experience for a small child, and removes the burden of programming the function to the factory, a parent, a teacher, or an older child. The intelligent toy brick provides a much different, much more accessible user experience than the multi-brick intelligent systems described in prior art.

Description of Baseplate Assemblies

FIG. **36** is an overall view of a baseplate assembly **200** including broadly a baseplate **202** removably mounted to an image generating device **204**. Device **204** is typically a pad computer, such as an iPad® computer made by Apple Computer, having a large display screen **206**. Image generating device **204** is often referred to as computer **204**. In some examples, baseplate **202** and image generating device **204** can be an integral, one-piece device. A portion of baseplate **202** in FIG. **36** is removed to disclose display screen **206** of image generating device **204**. The portion of baseplate **202** covering display screen **206**, commonly referred to as display region **208**, is preferably made of an essentially colorless, transparent material so that images generated by computer **204** at the display screen **206** are transmitted through baseplate **202** for viewing by a user, as well as other uses discussed below, at the display region. Display region **208** is surrounded by an outer region **210** which overlies the outer edge **212** of computer **204**. Baseplate **202** has coupling elements **14** extending from its upper surface **214** to permit toy blocks **10** to be removably mounted to the baseplate. In addition to being viewable by a user, images transmitted through display region **208** of baseplate **202** can also be used for interaction with toy blocks **10**, also discussed in more detail below. Baseplate **202** includes mounting structure **215** by which the baseplate can be removably mounted to the image generating device **204** so that display region **208** is positioned adjacent to and opposite display screen **206**. In this example mounting structure **215** in the form of a lip. Other types of mounting structures **215**, including clips and releasable adhesives, may also be used.

Display screen **206** may be a flat panel display where the light generating pixels are directly visible, such as with the screens of tablet computers. Other examples may be a different implementation where the image is generated remotely and transmitted to baseplate **202**; one example of this is shown in FIG. **37**. In this example, a DLP projection system **260**, such as available from Texas Instruments, may be used. System **260** typically includes a light source **262**, which, in some examples of the laser light source, which generates a light beam **262** which passes through a first optical element **264** and then onto the surface of a DLP mirror **266**. DLP mirror **266** can include over 1 million hinge mounted microscopic mirrors which project the light beam **262** containing the image through a second optical element **268** to baseplate **202**. Another alternative to the pad computer example is shown in FIG. **38**. In this example, a display screen **206** is positioned at an angle to a mirror **270** to direct the image from display screen **206** onto baseplate **202**. The technology for generating the image is can be such as but not limited to LCD, plasma, organic LED, lamp with color wheel and DLP chip.

The image can also be transferred to the upper surface **214** of the baseplate **202** in other manners. Two such examples are shown in FIGS. **39** and **40**. In these examples, baseplate **202** is made up of numerous optical fibers **274** extending from the lower surface **272** to the upper surface **214** with lower surface **272** being positioned opposite display screen **206** or other image generating surface such as DLP mirror **266**. The image created at upper surface **214** can be the same size or different size as the image created at the display screen **206**. In FIG. **40** the image created at upper surface **214** is larger than shown at display screen **206** while in FIG. **40** the images are the same size.

FIGS. **41** and **42** are top plan views of a baseplate assembly in which the baseplate includes a first portion **216**, generally consisting of outer region **210**, which generally overlies outer edge **212** of computer **204**, and a second portion **218** sized to fit within the interior of first portion **216** and overlie a portion of a display screen **206**. Second portion **218** defines an open region **220** which provides direct visual access to a part of display screen **206**. FIG. **43** shows the structure of FIG. **41** with an alternative second portion **218** of baseplate **202** occupying the entire interior of first portion **216** of baseplate **202** thereby completely covering display screen **206**. First portion **216** may be transparent, translucent or opaque while it is preferred that second portion **218** be made of an essentially colorless, transparent material to permit visual images to be transmitted therethrough.

FIG. **43** also illustrates an image **222** projected from display screen **206** onto display region **208** of baseplate **202**. While image **222** is typically a two-dimensional image, computer **204** can be of the type which generates an image viewable as a three-dimensional image, typically with the use of specialized glasses. Examples of technologies that can generate an image suitable for 3 dimensional viewing include the following. Stimulation of 3D can be achieved by generating two slightly different stereoscopic images on a flat screen, as would be seen by the left and the right eye. These images can be selectively directed to the left or the right eye by a variety of means. One method of selectively directing the image to one eye only, is to make one image of one color and the other image of a different color. The user then wears eye glasses with filters that only transmit one or the other color on the left and right eye, such that each eye receives a different image, as would be seen when viewing a physical 3 dimensional object. Another method of selectively directing the image to one eye only is by way of polarization. The two images can be projected by 2 separate sources of light of orthogonal polarization onto a single screen, and the screen viewed with eye glasses with orthogonal polarization filters for each eye. The images can also be projected or created by a single source that changes the image and the polarization of a filter in front of the single source at a speed adequately fast that the eye will see the presence of two images simultaneously.

Another type of three-dimensional imaging can be through the use of holographic projection. Holographic projection can be created by projecting a laser through a film that contains a prerecorded interference pattern of light from a solid object. A moving hologram can be created by replacing the film with a "Spatial Light Modulator" which can be an array of small movable mirrors as in a DLP chip. The mirrors can generate a varying interference pattern as would be created by a moving object, thus creating a moving hologram.

In some situations computer **204** includes a touch sensitive membrane **224** as a part of display screen **206** as shown in FIG. **44**. Pad computers typically include touch sensitive membranes as part of their display screens. Touch sensitive technologies can be broadly grouped into two technologies, single-touch and multi-touch. The single touch systems typically have four or fewer conductors and the multi-touch have a grid of X and Y conductors which are scanned. The conductors are typically in the form of two transparent sheets with transparent electrodes which are spaced apart by a resistive or dielectric medium, depending on if the touch is sensed by resistance change or capacitance change. When the sheets are pushed together or touched the magnitude of the resistance or capacitance change can be used together with the knowledge of the electrodes most affected by the change to compute the position of the touch.

FIG. **44** is a simplified partial cross-sectional view of an example of baseplate assembly **200** of FIG. **36** in which the image generating device **204** includes touch sensitive membrane **224** situated directly above the display screen **206**. Touch sensitive membrane **224** and display screen **206** are shown spaced apart from one another for purposes of illus-

tration. Access regions **225** are provided at positions on baseplate **202** to permit access to membrane **224**. In one example shown in FIG. **44**, access regions **225** are provided at coupling elements **14** at which portions of baseplate **202** surrounding coupling elements **14** are thinned, flexible elements **226**. This permits coupling elements **14** to be deflected by a user from the spaced apart position shown in FIG. **44** to a position, not shown, contacting touch sensitive membrane **224** to allow input to computer **204**.

FIGS. **45** and **46** show alternative examples of the structure of FIG. **44** in which the flexible elements **226** are thin, zigzag flexible elements **226** in the example of FIG. **45**, and are spaced apart flexible elements **226** created by cutouts **228** in baseplate **202** in the example of FIG. **46**.

FIG. **47** is a further alternative example of the structure of FIG. **44** in which access regions **225** are created by holes **230** formed in baseplate **202** at positions offset from the coupling elements. In this example, the user touches the touch sensitive membrane **224** directly with, for example, a stylus or the tip of the user's finger.

FIG. **48** is a simplified partial top view of a baseplate **202** including a grid **232** of a set of parallel, spaced apart first electrodes **233** and a set of parallel, spaced apart second electrodes **234**. First and second electrodes **233**, **234** are oriented perpendicular to one another. Electrodes **233**, **234** are electrically coupled to computer **204** to provide an indication of where on baseplate **202** the user is touching the baseplate. This technique is conventional and can be based upon resistance change or capacitance change depending on whether the material separating the electrodes is a resistive medium or a dielectric medium. Capacitive touch electrodes as shown in FIGS. **48** and **49** are generally designed so that the field that exists between the electrodes travels to the surface of the dielectric so as to be affected by touch. Electrodes **233**, **234** are preferably essentially transparent so not to interfere with transmission of the image from computer **204**. In capacitive touch sensing, two electrodes as seen in FIGS. **48** and **49** are separated by a dielectric medium such as the material **276** of baseplate **202**. As shown in FIG. **49**, the electric field lines **278** between the conductors **233**, **234** can be changed by the presence of another dielectric or conductive medium such as a finger F or a stylus. The change in the electric field lines **278** causes a change in the capacitance between the conductors **233**, **234**, which can be measured by electronic circuits to ascertain the position of touch. A good explanation of such technology is given in the Microchip TB3064 Document, and in application note AN3863 from Freescale semiconductor.

FIGS. **50-70** relate to the interaction between various playing pieces, including toys, tokens, game playing pieces and the toy bricks **10** discussed above, and a baseplate assembly **200**. To simplify the description of the following figures, in the discussion below the specific playing pieces will typically be referred to as toy bricks **10**. However, playing pieces other than toy bricks **10** may typically also be used.

FIG. **50** is a simplified top view of baseplate assembly **200** of FIG. **36** showing an image **222** projected onto display region **208** of baseplate **202**. Based upon the location of a toy brick **10**, or other playing piece, on the baseplate, information, such as a message or signal, can be provided the toy brick by the image.

FIG. **51** is a view similar to that of FIG. **50** but in which a portion of the image **222** generated by display screen **206** is dimmed to convey information to toy brick **10** by way of a first signal **235**. Generally speaking, using intensity variations of all or part of image **222** creates an integrated visual image **222** including visual images **223** and optically encoded message images **235**, sometimes referred to as first signals **235**, to permit information to be transmitted to toy bricks **10**.

In some examples, computer **204** will send an optically coded message as a series of intensity variations in time. These intensity variations will be received by toy bricks **10**, capable of receiving and responding to the optically coded message, that have been placed onto baseplate **202**. An example of what is sometimes referred to as an intelligent toy brick **10** including a light detector **42** is shown in FIGS. **2**, **4**,**59** and **64**. The intensity variations can be localized to a patch of pixels in display region **208** under/adjacent to each coupling element **14** as shown in FIGS. **50** and **51**. After a message is sent in the form of intensity variations at one coupling element **14**, a similar action would performed at the next coupling element **14**, so as to scan the entire baseplate **202**. The intelligent toy bricks **10** placed upon the baseplate **202** will respond via, for example, optical/RF/sound encoded second signal **238**, as shown in FIG. **59**, discussed below with reference to FIGS. **64-67**, to one or more receptors **236** on the baseplate **202** as shown in FIG. **52**. Preferably only one coupling element **14** and one toy brick **10** will be stimulated with a message at any one time, and only one toy brick **10** will send a second signal **238** to the receptor **236** of the computer **204**. The message sent from the toy brick **10** may contain information as to the type of toy brick placed upon the baseplate **202**. The computer **204** will then know the position of the toy brick **10** that is communicating its properties, since the computer knows the position of the patch of pixels that is sending the encoded message. In this manner, the computer **204** may command the intelligent toy bricks **10** placed upon it to perform functions, or even change the image **222** displayed on display region **208** interactively to perform a gaming function wherein the baseplate assembly **200** responds to the toy brick **10** placed upon it. A single layer of toy bricks **10** placed upon the baseplate **202** can be interrogated in this manner.

In some examples, it is possible to simultaneously stimulate more than one position with different optically encoded messages, since each patch of pixels, at each coupling element **14**, may simultaneously have different encoded intensity variations, the message encoding the position being stimulated. It is possible for one or more toy bricks **10** to simultaneously communicate with one or more receptors **236**, as is done by way of example in CDMA (code division multiple access) cell phones or as done in Anti Collision NFC Tags. Each toy brick **10** mounted to baseplate **202** will send the message it receives from the display screen **206** in addition to information about the properties of the toy brick, thereby enabling the image generating device **204** to compute the position and type of toy bricks placed upon it.

It can be seen by a person skilled in the art that the intensity variations encoding the message sent by the image generating device **204** can be at a level imperceptible to a user viewing the entire display region **208**, but is detectible by sensitive electronics on the toy brick **10** as placed upon the display region **208**. The encoding can be of adequate complexity so as to even be detectable over the intensity variations of a moving image. By way of example, the encoded message may be encoded on a carrier of a known frequency, as for example IR remote controls encode the message on a carrier at 40 KHz or so. An example of a miniature optical receiver is the SFH506 IR receiver/demodulator device made by Siemens, which is a fully integrated device capable of delivering a digital data stream from a modulated light signal. Such encoding allowing signals resulting from varying of an image to be distinguished from the encoded message, in much the same manner

as one radio station can be heard even though many radio stations and sources of radio frequency noise are present in the ether simultaneously.

The communication from the image generating device **204** to the toy brick **10** includes one or more of information requests and information sent, such as but not limited to send brick type information, send avatar image, send gaming powers of/weapons possessed, receives new avatar image, receive new gaming powers/weapons, and enable RFID/RF transponder for X seconds.

The communication from the toy brick **10** back to the display computer **204** through receptor **236** can be by way of example but not limited to:

1) An audible or inaudible sound sent from the toy brick **10** received by one or more microphones, acting as receptors **236**, attached to the baseplate assembly **200**, by way of example implemented as an audio modem with an audio codec chip such as the ADAU1772 chip from Analog Devices.
2) A visible or invisible light encoded message sent to one or more light receptors **236** through air or through light guides in the baseplate **202**, by way of example implemented with a miniature optical receiver such as the SFH506 from Siemens.
3) RF encoded signal, such as but not limited to, Bluetooth implemented with a module such as the SPBT2532C2.AT from STMicroelectronics, ZigBee implemented with an integrated circuit such as the CC2520 from Texas Instruments, or RFID implemented with an integrated circuit such as the Texas Instruments TRF7970A.

The communications from the toy brick **10** to the baseplate assembly **200** contain information such as but not limited to:

1) Shape and size of the toy brick **10** placed upon baseplate **202**,
2) Information from sensors located inside the toy brick **10**,
3) Gaming or characteristics or special powers weapons or appearance of an Avatar of the toy brick **10**.
4) A serial number, which can be for example an address into a lookup table on the computing device attached to the display or on the internet to provide the information in (1) or (3) above.

FIG. **52** is a top plan view of a baseplate assembly **200** including a receptor **236** which can receive a second signal **238** from a toy brick **10** mounted to the display region **208** of the baseplate **202**. The second signal **238** is generated in response to the information provided by the first signal **235** of image **222** projected onto the display region **208** of the baseplate **202**. The signal generated by the toy brick **10** can include information such as the type of toy brick and additional information such as a part of the message that was received from the baseplate which contains data encoding position information.

The message from the display can be encoded in space rather than time, such as a one-dimensional or two-dimensional barcode. FIG. **53** illustrate an example in which a portion of the image acting as first signal **235** is in the form of a two dimensional barcode **253** which can be scanned or imaged by a toy brick **10** placed on the display region **208** of the baseplate **202**. Toy brick **10** would then send a message to computer **204** with its characteristics and the barcode seen, enabling computer **204** to compute the position and type of the toy bricks **10** placed upon baseplate **202**.

An example of a formal software implementation of a scanning routine, is as shown in FIG. **54**, sends messages to bricks **10** via the image generating device **204**. The exemplary method implemented is best understood by realizing that the image **222** on the display screen **206** is stored in a memory (display RAM) as shown in FIG. **55**. By way of example, but not limited to a 1024×768 Display which has a memory array that is 1024×768 and each location of that memory array is capable of storing three RGB (red, green, blue) values, each value typically being 8 bits or 16 bits wide, allowing a number from 0-255 or 0-65535 respectively to express the color intensity. The intensity at each of these locations can be defined as D(n) as shown in FIG. **56**, where (n) is the spatial location. In the case of 1024×768=786432 gives (n) a range from 1 to 786432. The "intensity" can be a simple sum of the RGB values, and the intensity can be changed without changing the color by multiplying all three RGB values by the same number. Other variations such as a slight color change can also be utilized in order to encode a message.

Similarly, as shown in FIGS. **55-57**, other memory arrays of 1024×768 can be defined for other data with a correspondence between the data at a point (n) in those arrays and the corresponding point (n) of the image: I(n) can be the Image that is desired to be displayed, which is typically created independently by the gaming software running concurrently to the scanning software. C(n) is the communications data to be added on top of the image data, such that D(n)=I(n)+C(n) as shown in FIG. **56**. It can be seen that while (n) describes the spatial variation of the image, the equation is also a function of time (t) such that D(n)(t)=I(n)(t)+C(n)(t) which allows both the image and the communication data to vary in time and space. Such a temporal variation allows serial communication data on top of a moving image generated by the gaming routines. The addition (+) shown is by way of example and can be another mathematical function instead. In another embodiment, the message C(n)(t) may also be directed to an LCD backlight, which by way of example can be an array of individually addressable white LEDs.

Further, as shown in FIG. **57**, the communication data C(n)(t) to be added to the Image data is created by way of example but not limited to the message M(n)(t) multiplied or convolved with a modulation function U(n)(t), which yields C(n)(t)=M(n)(t)×U(n)(t). In this example, C(n)(t) need not vary for each display pixel (n), and may be the same message for a patch of pixels.

The modulation function U(n)(t) can be simple amplitude modulation of a carrier such as ASin(wt), or a more complex scheme like CDMA which allows many devices to talk at once.

The contents of the data received from a stimulated brick can then be stored in another 1024×768 RAM. In this manner information, such as the positions, gaming powers/weapons or Avatar images, of all toy bricks placed on the display baseplate is made available to any concurrently running gaming software, as a "map". By way of example, a block diagram of the data path for such a scheme is as shown in FIG. **55**.

FIG. **58** is a possible implementation of a baseplate **202** with triangulation capability. In this implementation toy bricks **10** with passive or active RFID tags **284** embedded in them as shown in FIG. **59**, are interrogated by an NFC (near field communication) reader **285** with an interrogation antenna coil **286** which is wound around the perimeter of the display region **208** of baseplate **202**. The reader **285** sends any data obtained from interrogation of NFC transponders within its vicinity to the computing device attached to the display **208** by means of device **287**, which may be a wired connection such as but not limited to USB, flash lightning port or a wireless transponder such as, but not limited to, Bluetooth, WiFi or ZigBee. In the case of a passive RFID tag **284** in the toy brick **10**, the coil **286** would power the tags from via near field magnetic coupling with the RFID receive coil **288** as

well as read the data from the tag. Since RFID Tags **284** normally transmit when interrogated by the coil **286**, triangulation is achieved by having a further circuit, as shown in FIG. **59**, in the toy brick, which only enables the tag to transmit data **290** (second locating signal) when an optical "transmit" message **292** (first locating signal) is also received simultaneously or previously from the display baseplate. The baseplate **202** will typically scan patches of pixels in sequence on a square grid, with the "transmit" message **292**, each patch of pixels typically being, but not limited to, a square of dimensions equal to the spacing between two adjacent releasable couplings of the toy brick. In this manner the positions and types of bricks on the baseplate can be ascertained by the baseplate assembly **200**, that is baseplate **202** and associated image generating device **204**. Most inexpensive passive RFID tags are "read only" and contain a unique 128 bit address. In the event of the use of a read only tag, a further database or look-up table containing the brick characteristics can be kept on the baseplate assembly **200** or even at a remote location accessible via the internet; such a database would be read and written to, allowing update and modification of the toy bricks virtual characteristics even though the tag is read only. Tags such as the TRPGR30TGC, which is a fully encapsulated tag currently used for pet identification, and the TRF7970A integrated circuit, both from Texas Instruments, and the MCRF355/360 from Microchip Technology, are examples of existing devices which may be slightly modified to achieve this function. The circuits required for the reader are given by way of example in the MCRF45X reference design and application notes AN759 and AN760 from Microchip Technology. Other more complex protocols such as but not limited to the use of "Anti Collision Tags", which can have several tags being enabled to transmit at once, can also be used.

A playing piece **10** which can interact with a baseplate assembly **200** capable of triangulating its position in a manner as shown in FIG. **59** is also possible. By way of example, a Hot-Wheels® Toy car equipped in a similar manner as shown in FIG. **59**, may be rolled over a triangulating baseplate **202**, such as shown in FIG. **58** or **60**, and an image of a racetrack may appear on display region **208** of baseplate **202** with the car in the middle of the racetrack. In another example, a Small Barbie Doll® with such a transponder as in FIG. **59** may when placed on a display region **208**, cause the display screen **206** of computer **204**, and thus display region **208** of baseplate **202**, to show a Tea Party and emit relevant sounds. Indeed a Barbie doll equipped with a speaker may be recognized at a certain position on display region **208** of baseplate **202** and sent speech (via the display messaging system as described in FIG. **55**) to recite and to interact with a "Ken" Doll placed at a different position on the display region, who may be sent different speech (via the display messaging system) to recite. A gaming token type of playing piece equipped with flashing lights may be sent a message to flash lights if it was recognized as being placed at the correct position on the display to win.

A tablet computer and smart phones with embedded NFC readers, such as the Google Nexus 10, typically have smaller interrogation coils which do not encircle the entire display screen **206** as shown in FIG. **58**, are currently available for the purpose of NFC Credit card transactions and for sending photos and data between such devices when they are held together and "tapped". Such a device would need to be modified to implement a scheme as described in FIG. **55** in order to triangulate the position of an object placed upon it.

It is also possible to have a toy brick or other playing piece **10** as shown in FIGS. **59** and **60** with two optical receptors **237** placed at different points on it. Each optical receptor enabling the NFC transponder **248** only when the optical "turn on" message is received by that particular receptor when the display below it stimulates it with a message. In this manner the position of two points on the toy, relative to the display, may be ascertained. This information allows the orientation of the toy with respect to the display to be determined. By way of example, a toy piece shaped as a flashlight may, when placed on the display assembly, be recognized as a flashlight and create a virtual beam on the display. The orientation and origin of the beam may be computed by knowledge of the position and orientation of the playing piece. The beam may even cast virtual shadows for other playing pieces placed on the surface of the display, or even illuminate and cast shadows for virtual objects that are displayed on the display.

Coupling elements **14** may be loose fitting bumps or pockets on the baseplate so as to constrain the bricks in the plane of the display but allow them to be easily removed when lifted up from the plane of the display. As suggested in FIG. **60**, in some examples, display region **208** can be made without any coupling elements **14**, particularly when the playing piece **10** is not a toy brick **10** or other playing piece having structure which allows it to be secured to upper surface **214** by coupling elements **14**.

FIG. **61** is a schematic representation of a baseplate **202** including column scan lines **240** extending in one direction and row scan lines **242** extending in a transverse direction, the scan lines bounding the coupling elements **14**. Electrical coils **244** are connected to the row and column scan lines **240**, **242** at their intersections for communication with toy bricks **10**, typically positioned directly above the coils. Column and row scan lines **240**, **242** and coils **244** can communicate with or provide inductively coupled power to the bricks, or both, placed directly above them by RF, electrical field or magnetic field. The number of connections required to communicate with the coils can be reduced by means of the XY scanned grid of column and row scan lines **240**, **242**. Such a baseplate **202** would preferably have some electronics such as a microcontroller or keyboard scanner circuit to scan the XY lines and communicate with a computing device via protocols such as but not limited to USB, Lightning Port or Bluetooth.

FIG. **62** show structure similar to that of FIG. **61** but having a light emitting device **246**, such as an LED, at each intersecting column and row scan lines **240**, **242** and adjacent to coupling elements **14**. LEDS **246** can send messages or provide power in the form of light, or both, to appropriately configured toy bricks **10** placed directly above them by blinking visibly or invisibly. The toy bricks can then communicate back to baseplate assembly **200** through one or more receptors **236** using, for example, RF, visible or invisible light, or sound as shown in FIGS. **64-67**. In the example of FIG. **64**, first signal **235** is received by an appropriate sensing element **30**, such as microphone **40**, light detector **42**, RF transceiver **44** or camera **48**, of toy brick **10**. A signal **238** is then provided to computing control element **32** which communicates with actuator **34** through lines **39** to create second signal **238** for receipt by one or more receptors **236** of computer **204**. Types of actuators **34** are given by way of example but not limited to in FIGS. **65-67**. Where an electrical message **294** from the computing and control element **32** is received by amplifier **58** which sends the signal to either a sound emitter **82**, or a light emitter **80** or an RF or NFC Transceiver **44** in order to communicate the second signal to the Baseplate. The actuators as shown in but not limited to FIGS. **65-67** may also be used by the baseplate.

A higher density of LEDs, or other light emitters **246**, per releasable coupling element **14** in structure such as shown in FIG. **62** can be the basis of a toy brick baseplate **202** which is capable of graphical display, but with less detail than would be possible with a conventional LCD. Such a baseplate would preferably have some electronics to scan the XY lines and communicate with a computing device via protocols such as but not limited to USB, Lightning Port or Bluetooth.

FIG. **63** and FIG. **68** show a baseplate assembly **200** including triangulating transmitters/receptors **250** at the four corners of baseplate **202** to permit the position of the toy brick **10** on the baseplate to be determined. Baseplate assembly **200** can use 3 or more RF/NFC/sound/light transmitters/receptors **250** at different positions on baseplate assembly **200**. Each of these transmitters/receptors **250** can emit a specific signal, preferably simultaneously, and each toy brick **10** would measure the time delay between the pulses received from each of the devices **250**. Each toy brick **10** can then compute its position by trigonometric methods and transmit the type of brick and its position back to baseplate assembly **200** through transmitters/receptors **250** by means of, for example, RF, light or sound transmissions. The reverse is also possible and equivalent, where the toy brick **10** emits a signal and the time difference of the signals being received by the transmitters/receptors **250** on the baseplate assembly **200** indicates the position of the toy brick.

Examples of baseplate assembly **200** have the ability to ascertain the position, orientation and characteristics of a toy brick **10** placed upon it, by passive means such as a camera and optical recognition, or by active means such but not limited to RFID or radio frequency triangulation. The toy bricks **10** placed upon baseplate **202** may in addition have sensors on them to transmit their orientation and motion. By way of example, a toy brick figure when manipulated in a waddling or walking manner may cause the scenery displayed on the baseplate to advance as if the toy brick figure were walking through the environment.

The manipulation of smaller toy bricks **10** across upper surface **214** of baseplate **202** may also cause avatars in 2D or 3D to appear on display screen **206** and interact with other features of the displayed image. The virtual characteristics of a toy brick or toy brick figure may be stored in nonvolatile memory on the baseplate assembly **200** or even nonvolatile memory on the toy brick **10** being manipulated. Further, the virtual characteristics of the toy brick being manipulated may change due to interaction with the environment on upper surface **214** of baseplate **202**. The changed characteristics may be retained in the physical toy brick **10**, or elsewhere, such as at a remote location on the internet, such that the toy brick when taken to a different baseplate assembly **200**, the current baseplate assembly **200** may recall the exact environment on the display screen **206** of the prior baseplate assembly **200** and also the characteristics of the avatar from the previous interactive experience with the prior baseplate assembly.

The interaction between the baseplate assembly **200** and the toy brick **10** placed upon it may be two-way. By way of example, a toy brick **10** that is equipped with a similar but smaller display device may receive images to be displayed on its surface, dependent on its position on the baseplate. By way of example, a figural toy brick **10** may change its displayed image to a beach garment when moved onto a beach scene on the baseplate **202**. By way of another example, a toy brick could make a splashing noise when placed on a part of a display region **208** which has a water feature; the display screen **206** may in addition show the resulting water splash.

A baseplate assembly **200** with triangulation capability may also be used as a virtual building environment. A toy brick **10** that is moved over upper surface **214** can cause an avatar of the same toy brick **10** to appear on display screen **206**, and then by a clicking/cementing motion/gesture, the avatar associated with that toy brick may be cemented to a virtual structure, and the procedure repeated. The avatar need not be of the same shape as the physical toy brick, and selection of the shape of the avatar may be by menu structure displayed on display screen **206** or even by some physical manipulation of the toy brick or other triangulatable object.

In another example, the display screen **206** may show schematic instructions, for example, for the building a toy brick structure or even an electrical circuit with circuit elements made of releasable couplings such as in Snap-Circuits® sold by Elenco Electronics, Inc., of Wheeling Ill. The exact life size image of the building block or circuit element may be displayed on the display screen **206** under the releasable coupling elements **14** where it is to be snapped in, so that a child may create the assembly with ease.

It should be noted that an image generating device **204** may have all the features that by way of example an iPad, or similar computing device, can have. By way of example, one or more the following may be possible: reaction of the image to touch, rechargeable power supply, programmable response to motion or time course of motion, or orientation, integral camera, Bluetooth connection, WiFi connection, NFC reader, ability to play movies, ability to display a touch sensitive interactive game, ability to send and receive audible signals or optically encoded transmission and the like.

In another embodiment, baseplate assembly **200** may form a board game such a Monopoly board game. The Monopoly figures, houses, and hotels, may all be toy brick pieces, and their motion and position may be automatically sensed as discussed above. By way of another example, a game of Scrabble® may be played with toy bricks with letters on them being placed on upper surface **214** displaying a Scrabble game board, the score even may be automatically computed and displayed by automatic identification of the position and type of toy bricks **10**, acting as letter tiles, placed on baseplate **202**.

In another embodiment, players of a game may interact with a baseplate assembly **200** by means of smaller computing devices such as smart phones. Each player may affect the main displayed image on display screen **206** by means of software on the baseplate assembly **200** and which communicates with software on smaller computing devices. The smaller computing devices may in addition have clear baseplates attached, and placement of toy bricks on the baseplate on the smaller devices may affect a displayed image or game in the larger baseplate assembly **200**, or even on a display screen **206** with no baseplate **202**. Several smaller devices may simultaneously or sequentially communicate with, and affect the environment of the larger baseplate assembly **200**. The environment may be fully interactive, such that by way of example, Monopoly money may be taken from one player and given to another player, and the amounts displayed on the main baseplate assembly **200**, or even transferred between the smaller computing devices, depending by way of example on movement of toy brick figures on the main baseplate assembly **200**.

In another embodiment, is also possible to extend and route the display image and messaging in a 3rd dimension away from the plane of the display with the use of opaque, translucent or clear toy bricks **10** with optical fibers **274** or other light guides embedded in them as shown in FIG. **69**. In this manner, by way of example a toy brick Christmas tree with

twinkling lights or an Ice Castle complete with twinkling lights on the turrets can be made. A toy brick shaped as a Christmas tree with light guides may be recognized by the baseplate assembly **200** and automatically illuminated by the display with a twinkling light pattern. Note that this embodiment differs from other embodiments in which toy brick **10** is clear or transparent because the image is not visible through the brick instead appears on the surface of the brick. In FIG. **69** a combination of straight, parallel optical fibers **274** and curved optical fibers **274** are used to direct the image to more than one surface of the toy brick. In other examples, the optical fibers **274** could all be of one type.

Description of Image Generating and Playing-Piece-Interacting Assemblies

An example of an image generating and playing-piece-interacting assembly **296** is shown in FIGS. **55** and **70**. In this example, image **222** includes visual image **223** and optically encoded message image **235**, sometimes referred to as first signal **235**, to permit information to be transmitted to toy bricks **10** or other play pieces **10**. Assembly **296** is shown in FIG. **70** as a simplified schematic representation of components and devices constituting assembly **296** and suggesting their interaction. It should be noted that in some examples associated with FIG. **70**, a baseplate **202** is not used but rather receptor **236** is operably coupled to an image generating device **204**, typically a tablet computer. In such examples, toy bricks **10**, or other playing pieces **10**, can be positioned directly on display screen **206** of image generating device **204**. In other examples, a baseplate **202** can be used with receptor **236** typically mounted to baseplate **202**. In either event receptor **236** is operably coupled to the image generating device **204**, typically through a wired connection. Initially, some definitions and explanations are in order.

The optically encoded message image **235**, is a one way signal from the display screen **206** of image generating device **204**, and sometimes through display region **208**, to the optical display message sensor **237** of playing piece **10**. Optical display message sensor **237** generates a first signal **241** based at least in part on the optically encoded message image **235** and is a distinct component from any other sensor on the playing piece **10**.

The second signal **238** is a one-way, or a two-way, transaction between the messaging transponder **248** of the playing piece **10** and the receptor **236**. This messaging transponder **248** on the playing piece **10** is distinct from any other actuator on the playing piece. The messaging transponder **248** can be by way of example but not limited to, NFC, WiFi, Zigbee, Bluetooth, or infrared signal.

Sensors **30** are distinct from the optical display message sensor **237** which receives the first signal **235**. Sensors **30** may include components such as but not limited to temperature sensors, touch sensors, force sensors. In some examples, toy piece **10** does not include any sensors **30**.

Actuators **34** are distinct from the messaging transponder **248** on the playing piece **10** which creates and transmits the second signal **238**. Actuators **34** may be, but are not limited to, light emitters or sound emitters or another transponder on the playing piece **10**. As with sensor **30**, in some examples, toy piece **10** does not include any actuators **34**.

Receptor **236** communicates with the messaging transponder **248** on the playing piece **10**. The receptor **236** may be a one way or two way transponder. The following are examples of methods of triangulation of toy pieces **10** using optically encoded message images **235** thereby determining the physical location of a playing piece **10**, typically relative to the display screen **206**.

In a first example, the same optically encoded image message **235** being scanned across the display screen **206** is scanned sequentially across patches of pixels. In this example, the message is essentially "turn on messaging transponder **248**". The receipt of the first optically encoded message image by the optical display message sensor **237** turns on the messaging transponder **248**, described as a transmitter/transceiver in FIG. **55**, on the playing piece **10** above the currently stimulated patch of pixels, for a certain period of time. This starts a one or two way, second message interaction with the image generating device **204** through the receptor **236**, described as a receiver/transceiver in FIG. **55**. Receptor **236** may be by way of example an RF transponder. The position of the playing piece **10** is revealed to the image generating device **204** because the position of the optically encoded message image **235** is known at the time when the second message is received.

In another example, a different first optically encoded message image **235** is sent at different physical locations of the display screen **206**. These different message images **235** can be sent simultaneously at all locations or scanned one patch of pixels at a time. The differences between the message images can be, by way of example but not limited to, determined by encoding the X,Y coordinates of the location which is being stimulated. The playing piece **10** receives this message via the optical display message sensor **237** and can, when communicating with the receptor **236** at a subsequent time, by way of the messaging transponder **248**, not necessarily coincident with the time of receipt of the first optically encoded message image **235**, send the contents of first optically encoded message image **235** received in addition to data about the playing piece **10** itself. The image generating device **204** then knows the position of the playing piece **10** and the type of playing piece **10**.

Messaging can also be in addition to or instead of triangulation. For example, optically encoded message image **235** can contain data for actuators **34** on the playing piece **10**. For example, the data for an actuator **34** can be to turn the playing piece **10** to a blue color. This optically encoded message image **235** may be sent coincident with a visual image **223** showing water, such that any playing piece **10** placed on the visual image of water will turn blue. It should be noted that this does not require generation of a second signal **238** to receptor **236**, nor does it require triangulation of the position of the playing piece **10**.

In another example, second signal **238** sent by the messaging transponder **248** on the playing piece **10** to the receptor **236** may contain additional data from sensors **30** on the playing piece **10** in addition to other data. For example, the temperature of the playing piece **10** may be sent to receptor **236**, or the push of a button on the playing piece **10** can send a "shoot" signal to the receptor.

The message interaction involving second signal **238** between the messaging transponder **248** on the playing piece **10** and the receptor **236**, may be a two way communication, which can send data for actuators **34** on the playing piece **10**. For example, speech can be sent to a speaker type of actuator on the playing piece **10** by way of the second message interaction.

Two or more playing pieces **10** on the display screen **206**, or on the display region **208** of a baseplate **202** when used, may interact with each other through the display screen based first signal **235** and subsequent second signal **238** to the receptor **236**. Examples include but are not limited to the following.

Two playing pieces **10** may be placed and oriented to face each other and a shoot button type of sensor **30** on each toy

piece pushed, the progress of the bullet or other projectile is shown on the display screen **206**, either directly on the display screen or as viewed on the display region **208** when a baseplate **202** is used. This could be followed by the playing piece **10** turning red if hit. Such an interaction using the first and second signals **235**, **238** to compute position, in addition to the second signal **238** encoding the shoot button being pushed, in addition the one way optically encoded message image or the second signal which is a two way transaction in this example, sending a command to the playing piece **10** being hit to turn red.

Two or more playing pieces **10** on the display screen **206**, or baseplate **202** when used, may interact with each other directly without using the display transponder **248** through piece-to-piece signal **254**. For example, the playing pieces **10** may compute their positions with the information in the first display message image **235**. Then the playing pieces **10** may communicate directly with other playing pieces **10** using the messaging transponder **248** or another separate transponder; receptor **236** is not involved in the transaction.

The above descriptions may have used terms such as above, below, top, bottom, over, under, et cetera. These terms may be used in the description and claims to aid understanding of the invention and not used in a limiting sense.

While the present invention is disclosed by reference to the preferred embodiments and examples detailed above, it is to be understood that these examples are intended in an illustrative rather than in a limiting sense. It is contemplated that modifications and combinations will occur to those skilled in the art, which modifications and combinations will be within the spirit of the invention and the scope of the following claims. For example, images may be transmitted to display region **208** using a fiber optic array extending between image generating device **204** and the display region of the baseplate **202** as shown in FIGS. **39** and **40**. Such a fiber optic array may or may not extend from a display screen **206** on image generating device **204**.

Any and all patents, patent applications and printed publications referred to above are incorporated by reference.

What is claimed is:

1. An image generating and playing-piece-interacting assembly comprising:

an image generating device having a display screen on which generated images can be displayed;

the generated images comprising integrated visual and optically encoded message images;

a touch sensitive membrane operably coupled to the image generating device to allow a user to provide touch input;

a receptor operably coupled to the image generating device;

a first playing piece at a first location relative to the display screen, the first playing piece comprising:

an optical display message sensor configured to receive the integrated visual and optically encoded message image and to generate a first signal at least partially based upon the optically encoded message image;

a messaging transponder coupled to the optical display message sensor for receipt of at least the first signal from the optical display message sensor; and

the messaging transponder coupled to the receptor for generating and sending to the receptor a second signal at least partially based upon the first signal; and

a second said playing piece at a second location relative to the display screen, wherein the second said playing piece comprises an optical display message sensor configured to receive an integrated visual and optically encoded message image at least partially based upon the second signal from the first playing piece.

2. The assembly according to claim **1**, where in the receptor is at least one of a sound receptor, an electromagnetic radiation receptor, and a magnetic field receptor, and the second signal comprises a corresponding one of a sound second signal, an electromagnetic radiation field second signal, and a magnetic field second signal.

3. The assembly according to claim **1**, wherein the optically encoded message image is visually imperceptible to a user.

4. The assembly according to claim **1**, wherein the optically encoded message image contains information encoded as being addressed to a specific playing piece.

5. The assembly according to claim **1**, wherein the second signal comprises one or more of the following (1) graphic representation regarding the first playing piece, (2) other information regarding the first playing piece, and (3) an address into at least one of a local database, a remote database, a look-up table; which contains information regarding the first playing piece.

6. The assembly according to claim **1**, wherein the optically encoded message image changes according to the physical position of the optically encoded message image on the display screen.

7. The assembly according to claim **6**, wherein the optically encoded message image contains information regarding at least one of (1) coordinates for the physical position, and (2) information regarding the visual image portion of the generated image at the physical position, (3) gaming data for the playing piece, (4) data for an actuator on the playing piece.

8. The assembly according to claim **1**, wherein the optically encoded message image is generated at a plurality of physical positions on the display screen.

9. The assembly according to claim **1**, wherein each of the first playing piece and the second playing piece comprises a playing-piece-to-playing-piece communication device to permit transfer of messages therebetween.

10. The assembly according to claim **1**, wherein the first playing piece comprises a second optical display message sensor operably coupled to the messaging transponder.

11. The assembly according to claim **1**, wherein the second signal provides information to the image generating device as to where to display optically encoded messages for the first playing piece.

12. The assembly according to claim **1**, wherein the second signal generated by the first playing piece is automatically generated without further user interaction following receipt of the optically encoded message image by the optical display message sensor.

13. The assembly according to claim **1**, wherein the first playing piece comprises a sensor coupled to the messaging transponder to provide sensor data to the messaging transponder, so that the second signal can be generated at least in part based on the sensor data.

14. The assembly according to claim **1**, wherein:

the first playing piece comprises at least one of (1) an actuator operably coupled to receive a message from the optical display message sensor, and (2) an actuator operably coupled to receive a message from the messaging transponder;

the message comprising data for actuation of the actuator.

15. The assembly according to claim **14**, wherein the data for actuation of the actuator causes the actuator to do at least one of the following: generate a colored light, generate an image, generate a sound, cause movement.

16. The assembly according to claim 1, wherein the optically encoded message image displayed at the first location is changeable with time.

17. The assembly according to claim 1, further comprising an energy-transmitting near field communication (NFC) antenna and the playing piece comprises an energy-receiving antenna, whereby the NFC antenna can provide magnetically coupled power transfer to the first playing piece.

18. The assembly according to claim 1, wherein:

the first playing piece capable of generating a message; and wherein:

at least one of the first playing piece and the image generating device includes computer program instructions stored on a non-transient storage medium.

19. The assembly according to claim 1, wherein the optically encoded message image contains information regarding physical position coordinates for the optically encoded message image.

20. The assembly according to claim 1, further comprising:

one or more coils for transmitting power to the first playing piece; and

wherein the first playing piece comprises a coil for receiving power from said one or more coils for transmitting power.

21. The assembly according to claim 20, further comprising a baseplate mountable on the display screen, the baseplate comprising a display region, the display region comprising coupling elements, by which playing pieces can be releasably mounted to the display region, the baseplate further comprising said one or more coils for transmitting power.

22. An image generating and playing-piece-interacting assembly comprising:

an image generating device having a display screen on which generated images can be displayed;

the generated images comprising integrated visual and optically encoded message images;

a touch sensitive membrane operably coupled to the image generating device to allow a user to provide touch input;

a receptor operably coupled to the image generating device;

a first playing piece at a first location relative to the display screen, the first playing piece comprising:

an optical display message sensor configured to receive the integrated visual and optically encoded message image and to generate a first signal at least partially based upon the optically encoded message image;

a messaging transponder coupled to the optical display message sensor for receipt of at least the first signal from the optical display message sensor; and

the messaging transponder coupled to the receptor for generating and sending to the receptor a second signal at least partially based upon the first signal;

a second said image generating device generating integrated visual and optically encoded message images;

a second said playing piece at a second location relative to the display screen of the second image generating device;

the first and second image generating devices being operably coupled; and

wherein the second said playing piece comprises an optical display message sensor configured to receive the integrated visual and optically encoded message image from the second said image generating device at least partially based upon the second signal from the first playing piece.

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